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):

Development of Programmatic CDM Project for SWH installation under MNRE, UNDP/GEF Global Solar Water Heating Market Transformation and Strengthening Initiatives: India Country Programme.
Version: 4
Date : 18/12/2012

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

General Operating and Implementing Framework of PoA
Rationale to Design the PoA

In order to meet the objective of enhancing the outreach and increasing penetration as well as usage of solar water heating technology in the country MNRE under the UNDP/GEF programme has initiated the development of programmatic CDM project. M/s G K Energy Marketers Pvt. Ltd is selected as the co-ordinating and managing entity to facilitate development of the PoA to foster the dissemination and penetration of SWH technology across the country.

Organisational Structure of the PoA

M/s G K Energy Marketers Pvt. Ltd is selected and appointed as the coordinating and managing entity (CME) by MNRE-UNDP/GEF and the agency is entirely responsible for development and implementing the CDM PoA and facilitating development of the CPA's to be included under the PoA. The CME will be solely responsible for facilitating continuation of CPA inclusion under the programmatic CDM PoA in association with other identified stakeholders.
The CPA under the PoA will aggregate solar water heater installation across the country (India). The aggregations of installation to be conceived under each CPA of the PoA can be facilitated in association with CME by either of the parties listed below[1]:

- Beneficiaries/ end users of solar water heating technologies.
- Private/public limited company.
- Manufacturer/ distributor/supplier of SWH system or accredited channel partner[2](including ESCO and RESCO).
- Central and state government ministries and departments and their organizations
- State nodal agencies, utilities, local bodies, PSUs
- Reputed non-governmental organizations (NGOs).

Structuring of the CPA and User Agreement

The procuring end user of SWH system by virtue of the investment is the owner of CDM revenue. However in most cases the annual CER potential as against each installation is too low for applying to UNFCCC owing to the higher transaction cost and stringent registration procedure. The program is facilitated to aggregate large number of emission reduction activities (installed SWH systems in

[1] M/s G K Energy Marketers Pvt. Ltd will however act as the CME for all the CPA to be included in the title PoA
[2] http://mnre.gov.in/file-manager/UserFiles/list_channelpartners_st_jnnsm.pdf

residential and commercial estalishment) which can result in greenhouse gas emission reduction and contributing to climate change mitigation initiative. The PoA is planned to help end users in sourcing carbon credit revenue and also motivate other beneficiaries in investing in similar initiatives. Since the owner of the CER and the project participant are different entities an end user agreement is to be signed between the CME and the end user so as to affirm upon the roles and responsibilities of the CME and end user. The user agreement is to create a structure whereby the

- The beneficiaries or end user cede (transfer the CER ownership right of) all CER to the CME.
- The beneficiaries or end user agrees to co-operate with the CME or its partner/appointee in monitoring.
- Agrees to share the relevant document and co-operate with the DOE during validation /verification.
- The CME on the other hand will help the user in selecting the appropriate system in terms of technology, capacity and ensure appropriate installation.
- The CME or its partner/appointee is to facilitate periodic operation and maintenance of the systems.
- Disburse revenue to the user either in terms of service or financing after factoring the administrative and monitoring expenditure based on the capacity of the system.
- The CME will be responsible towards providing unique identification number for all systems to avoid double counting
- The CME will be responsible for appointment of DOEs for validation, CPA inclusion and verifications and facilitating CER transaction

As a part of the programmatic CDM project activity M/s G K Energy Marketers Pvt. Ltd will have separate agreement with each key stakeholders and beneficiaries to be involved under each CPA of the PoA. The agreement will be framed to clearly define and demarcate the roles and responsibilities of each party under the component project activity and revenue sharing arrangements between the parties of the agreement.

Role of CME

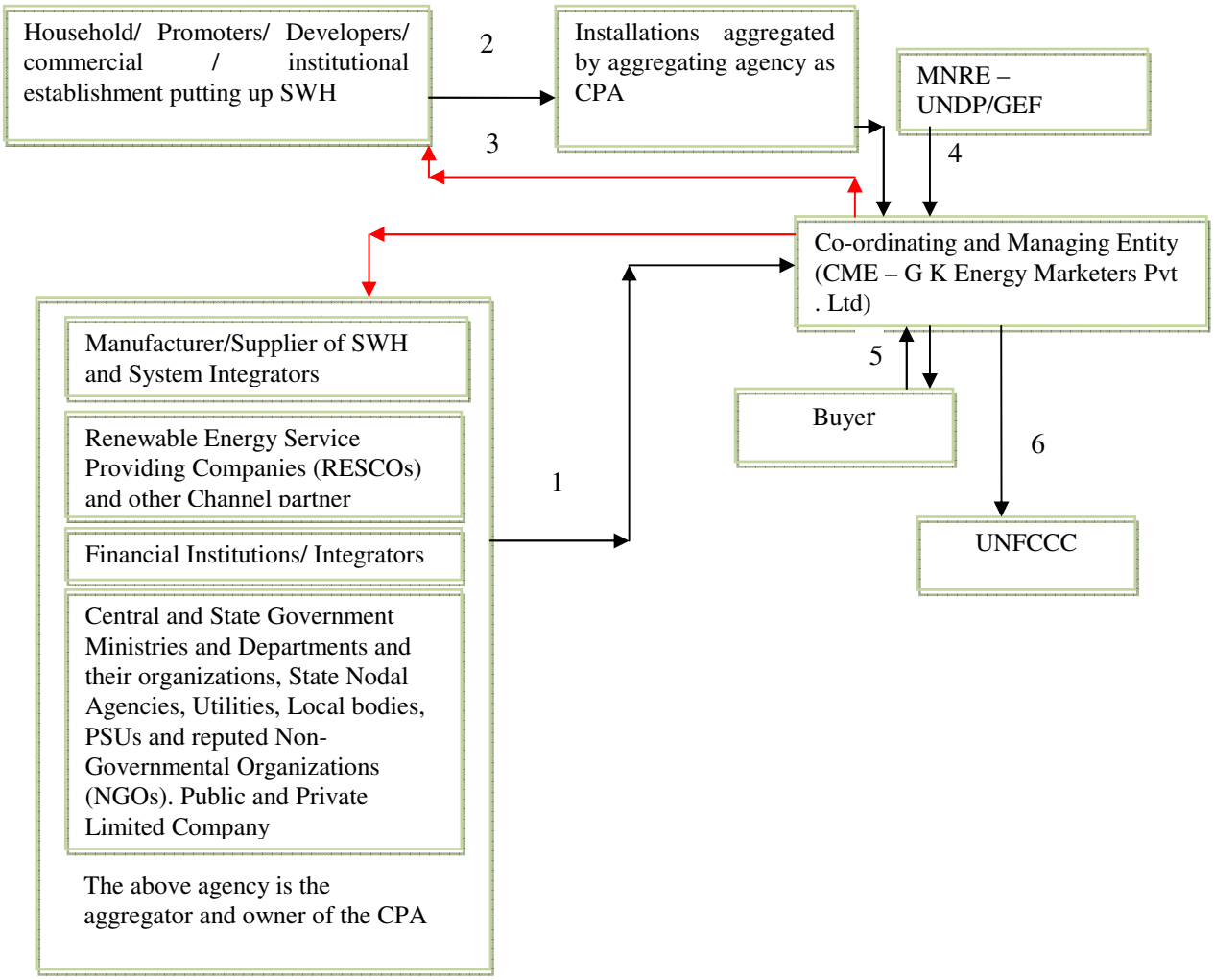
M/s G K Energy Marketers Pvt. Ltd (CME) will act as the focal point of all communication with Indian DNA, if required DNA of other parties, DOE's, CDM EB and others statutory body if any as required for registration of the CDM PoA and inclusion of subsequent CPAs in the PoA's. The CME will also ensure that solar water heating technologies meet the specified standards (BIS and MNRE) of the programme as highlighted in the subsequent section, thereby ensuring that the quality of both the systems and the installations is not compromised and the systems and the monitoring systems (wherever applicable) are maintained across the crediting period and all relevant data information are archived and retained for a period of two years after the end of last crediting period.
The CER revenue to be received as a part of the CDM programme activity (CPA) will be passed on to each end user and stakeholder in line with the contractual agreement by CME **.**

Technical support to CME

CTRAN Consulting will support the CME in co-ordination and management the PoA and inclusion of CPAs under the PoA, including development of POA-DD and CPA DDs, management of CDM cycle till registration, supporting CME in selection of the CPA to be included in the PoA, implementation of the monitoring plan, calculation of the resulting emission reductions, preparation of the monitoring reports, and transaction advisory across the duration of the PoA.

The General operating and implementing framework of the PoA is presented as follows:

Figure 1: The General operating and implementing framework of the PoA



1. End use Agreement (Bipartite), 2. End use Agreement (Tripartite), 3. Transfer of CER Revenue, 4. Support towards registration, 5. ERPA with buyer , 6: Co-ordination with UNFCCC for registration and subsequent inclusion of CPA in the registered PoA

Stated Goal of the PoA

The titled small scale CDM programme of activities is an initiative under MNRE –UNDP/GEF umbrella programme with the goal of enhancing the outreach and increasing penetration as well as usage of solar water heating technology as a clean and sustainable energy solution to meet the low pressure hot water requirement across domestic and commercial establishment. The project will contribute towards increased penetration of SWH technology by providing end users with comprehensive financing and

maintenance options resulting in overcoming financial[3], technological[4] and other related barrier that confronts the development of the solar water heater sector. Widespread dissemination of SWH system aimed under the program of activity will result into reducing electrical peak demand, conservation of electricity and/or fossil fuels usage and reduction of greenhouse gas emission[5] associated with production of electricity/ combustion of fossil fuel and thereby providing a clean non-polluting option for water heating.

The solar water heater systems to be installed under the component project activity will replace existing water heating system (retrofit project) or prevent installation of electric or fossil fuel based water heating system (electric heater followed by fossil fuel fossil fuel based geysers/ heaters are predominantly used to obtain low pressure hot water[6]). The programme of activity through increased penetration of solar water heater technology will result in reduction of fossil fuel combustion or electricity usage which in turn will lower greenhouse gas emission and thereby contribute towards the objective of National Solar Mission (Mission framed under National Climate Change Action Plan) aimed at promoting solar energy technology as a measure towards controlling the anthropogenically emanated greenhouse gas accumulation in the atmosphere and enhances the ecological sustainability of India's development path while addressing energy security.

A solar water heater system basically comprises of a single or an array of solar collectors (Evacuated tube collector or Flat plate collector) to convert solar radiation incident on the collector area into usable thermal energy and insulated tank to store hot water as the major component. Insulted pipelines, valves, stands for holding the collector and hot water tank, pump (for forced draft system only) are the other accessories of the SWH system. The solar energy incident on the absorber panel coated with selected coating transfers the heat to fluid in the riser pipes underneath the absorber panel during the day time. Water (thermic fluid in cases where water cannot be used as working fluid in SWH system) in solar collectors gets heated up which is either pumped or flown automatically on thermosiphon principle to the storage tank. Hot water stored in the tank is thereafter used for various applications. The Technology options to be conceived under the programmatic CDM are:

- Flat Plate collector based SWH system (Thermosiphon and Forced Draft)
- Evacuated Tube Collector based Solar Water Heater (Thermosiphon and Forced Draft)

Broadly, the solar water heating systems can be classified under are of two categories - closed and open system. In the closed loop system, heat exchanger is installed to protect the collector from hard water/ from freezing temperatures in the cold regions and thermic fluid is used as a heat transfer medium. In open loop system either thermosiphon or forced circulation system, the system is devoid of heat exchangers. The thermosiphon are suitable for domestic and small institutional systems, provided the water is treated and potable in quality. The forced circulation systems employ electrical pumps to circulate the water through collectors and storage tanks.

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[3] Solar Water Heating System- A Review of Global Experiences – Prepared by MNRE and REEEP – page no 15 (http://www.aeinetwork.org/reeep/doc/DIREC_Background.pdf) outlines that the higher initial investment is a major reason for lower penetration of the technology.

[4] The MNRE – REEP study referred above also outlines the weakness in supply chains comprising of the lack of technician for installation, dearth of trained and competent planning engineers for improving design and subsequent operation and maintenance in the post installation period is a significant technological barrier.

[5] http://www.solarwaterheater.gov.in/page.php?pid=42

[6] Solar Water Heating System- A Review of Global Experiences – Prepared by MNRE and REEEP – page no 5, (http://www.aeinetwork.org/reeep/doc/DIREC_Background.pdf)

The systems to be considered under the project activity will be manufactured either in accordance to MNRE or BIS approved standard. The CME will ensure that the products meet the specified quality standard and the technical standard outlined in the subsequent section. The SWH system can either be a retrofit unit i.e. replacing existing electric/ fossil fuel based water heating system in existing facility or new construction project. The new construction project will include installation of SWH systems across:

1. New facility(ies)
2. In existing facility(ies) that prior to the project implementation do not have installed water heating system.
3. SWH system installed in existing facility(ies) that require expansion of existing water heating capacity.
4. Replacement of failed solar water heating system at existing establishment.

The project will result into:

1. Enhancing Penetration and scalability of solar water heating technologies: There are substantial barriers preventing penetration of solar water heater technology. Amongst the most pervasive barriers preventing the diffusion are related to high upfront investment, weak public policy framework, weak institution, lack of promotion and technological failure[7].
   The purpose of the project activity is to introduce carbon finance as a vehicle towards providing incentives necessary to enhance the penetration of SWH system.
2. Reducing Green house gas emission and abate environmental pollution- The use of Solar water heating technologies will help in displacing use of the existing electricity/fossil fuel based water heating options thereby reducing consumption of electric energy or other fossil fuel and associated emission reduction.
3. Enhance the investment opportunity and growth of solar water heating market.
4. Confirming operation of the system across its lifetime through maintenance package as the earning of the financial benefit is dependent upon the successful operation of the system across its lifetime.
5. Contribute towards sustainable development and low carbon economy in following ways:

   a. Social well Being
      - The use of solar water heater will reduce fossil fuel or electricity consumption for sufficing the hot water requirement at residential and commercial establishment. The reduction in electricity consumption will in turn reduce pressure from the grid[8] that experience peak shortage ranges around 14% and energy shortage around 8.8% at national level[9]. As per the news article in Business Standard quoting the projection of Central Electricity authority, the energy deficit in the country in 2011-12 will be in the range of 10.3% while the peak deficit of 12.9% will be experienced[10]. The higher level of installation of solar water heater under the PoA will help to secure electricity supply thereby contributing to the economic development.
      - Security of energy source: From an energy security perspective, solar is the most secure of all sources, since solar radiation it is abundantly available. It is in this situation the promotion of

[7] Barriers to the diffusion of Renewable energy technology – Dr. B. Sudhakar Reddy , Indira Gandhi Institute of Development research, http://uneprisoe.org/RETs/MaharashtraStudy.pdf (Pg 31, 42 and 52-56)
[8] Solar Water Heating System- A Review of Global Experiences – Prepared by MNRE and REEEP – page no 5and 6 (http://www.aeinetwork.org/reeep/doc/DIREC_Background.pdf)
[9] Report of The Working Group on Power For Eleventh Plan (2007-2012) – (pg 4 chapter 1.) http://planningcommission.nic.in/aboutus/committee/wrkgrp11/wg11_power.pdf
[10] http://www.business-standard.com/india/news/power-deficit-for-2011-12-pegged-at-103-per-cent/438884/

solar water heating technology can contribute to enable the country to meet long-term energy needs[11].

b. Economic Well Being
- The project activity will result in generation of employment opportunities[12] for professional, skilled and unskilled labour for manufacturing, installation, operation and maintenance of the Solar water heating system installed under the project activity.
- Accrual of CDM revenue will enhance the viability of the project and will therefore motivate other developers/users to invest.

c. Environmental Well Being
- Reduce green house gas emission associated with generation of equivalent quantum of electrical energy in fossil fuel based power plant or by abating fossil fuel consumption in the baseline scenario for meeting the thermal options.
- The project will also reduce emission intensity of different pollutant like SOx, NOx, and suspended particulate matter from the combustion of fossil fuel, reduce average effluent intensity, average solid waste intensity, harmful pollutant like mercury resulting from generation of power in fossil fuel based power plant.
- Reduce fugitive emission of green house gases associated with extraction and transportation of fossil fuel.

d. Technological Well being
- Act as cornerstone model towards promotion of usage of solar water heating technologies and help in enhancing the technical know how about the project activity.
- Successful revenue realisation from the project activity would thus encourage others stakeholders irrespective of sector to adopt the technology.

Proposed PoA is a voluntary action by the CME

The PoA is voluntary initiative of the MNRE under UNDP/GEF umbrella programme coordinated by M/s G K Energy Marketers Pvt. Ltd (CME). M/s G K Energy Marketers Pvt. Ltd (hereafter also known as CME[13]) is under no obligation to offer a programme for implementation and/or installation of solar water heating system. The programme is structured and configured towards alleviating the barrier specifically the financial and technological through carbon financing options.
As per publication in MNRE[14] a model regulation / building byelaw for installation of solar assisted water heating systems was circulated by the Ministry of Urban Development and Ministry of New and Renewable Energy to all to all local bodies of the states and union territories in 1999 for incorporation in their building bye-laws with a provision of mandating solar water heater usage in certain category of building. Based on circular about 21 states have issued necessary orders to their urban local bodies. Further, about 90 municipal corporations / municipal committees / development authorities in eight states have amended their building bye-laws or have issued orders in this regard. Enforcement of these orders / amended bye-laws are, however, very poor in most of the corporations/ municipalities majorly due to the lack of enforcement or penal provision.

[11] Jawaharlal Nehru National Solar Mission (http://india.gov.in/allimpfrms/alldocs/15657.pdf) (Pg 2)
[12] Solar Water Heating System- A Review of Global Experiences – Prepared by MNRE and REEEP – page no 15 and 16 (http://www.aeinetwork.org/reeep/doc/DIREC_Background.pdf)
[13] Coordinating and Managing Entity
[14] http://www.mnre.gov.in/file-manager/advertisement/rfp-undp-gef--feb2012.pdf (page no 6)

The lack of provision of enforcement in the regulation and uniformity of the policy is also evident from the gap between the total estimated potential and the current level of penetration of the technology in the country irrespective of the measures in terms provisioning of regulatory norms, awareness, financial and fiscal benefit offering by the state and central government towards promotion of the SWH technology. The solar water heater programme as of now has already faced wide spread non-compliance in the country and can be derived from the cumulative achievement of 5.73 million square metre[15] out of the total potential of 140 million square metre[16]. From above it can be concluded that the non-compliance of the mandatory provisioning of solar water heater is widespread across the country and the policy/regulation would not be systematically enforced and the PoA would lead to greater level of enforcement of existing mandatory policy/regulation by elevating the barrier preventing the commercialisation of the technology.

Brief outline of the 1st CPA (CPA0001)

The first CPA will include installation of 21,300 sq. metre of natural draft solar water heater collector within the state of Maharashtra limited to residential establishment satisfying the following conditions[17]:

- The size of the collector array per standalone system will be limited to $8m^2$
- The technical specification and the system and the installation will be adhered by paragraph 1-VI of the 10.c of AMSI.J

The net emission reduction from the CPA0001 considering the proposed installation is 8832 tCO_{2e} per annum.

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

1. **Coordinating or managing entity of the PoA –** M/s G K Energy Marketers Pvt. Ltd whose details are furnished in Annex I will act as the Co-ordinating and Managing Entity (CME) for the SSC- PoA and all CPA to be included under the PoA.

2. **Project participants being registered in relation to the PoA.:** M/s G K Energy Marketers Pvt. Ltd will be the project participant and will act as CME to all the CPA under the PoA.

   The project participants being registered in relation to the PoA are as follows

Name of the Party Involved ((host) indicates a host party)	Private and/or public entity(ies) Project participants (as applicable)	Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No)
India (Host)	M/s G K Energy Marketers Pvt. Ltd	No

[15] http://mnre.gov.in/mission-and-vision-2/achievements/ as on 30/07/2012
[16] http://www.solarwaterheater.gov.in/page.php?pid=42
[17] For the purpose of ex-ante estimation of emission reduction it has been conceived that 90% of the total installed capacity will be in operation under the crediting period and therefore the cumulative capacity of installation considered for the purpose of ex-ante estimation of emission reduction is 19,170 sq. meter. However the consideration of the proportion i.e. 90% of the system in operation is only for the purpose of exante calculation. The actual capapcity of the system in operation will be determined ex-post based on the result of the sample survey.

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

A.4.1. Location of the programme of activities:

The PoA is located within the political boundary of India, including all states and union territories.

A.4.1.1. Host Party(ies):

India

A.4.1.2. Physical/ Geographical boundary:

The boundary for the SSC-PoA is the geographical area within which all the SWH installation that is covered under the CPAs are to be included. The boundary of the PoA is the entire region of India, including all states and union territories. Thus the physical and geographical boundary of each SSC - CPA will be confined within the territory of India limited to its political boundary covering any or multiple number of states or union territories.
The boundary of the PoA is defined as the political boundary of India[18]. The Physical and geographical boundary of each SSC CPA will be defined in each CPA.

Figure 2: Political Map of India

[18] http://www.mapsofindia.com/maps/india/india-political-map.htm# as on 12/09/2012

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

The CPA under the PoA is to include installation of solar water heaters (natural or forced draft flat plate collector of 2 m^2 each and manufactured in accordance to approved BIS standard and natural or forced draft evacuated tube collector manufactured in accordance to approved MNRE standard specification) at residential, commercial, institutional and industrial establishment to suffice the low pressure hot water requirement. The baseline of the CDM programme activity includes options that were or would have been used to meet up the low pressure hot water requirement. The low pressure hot water requirement is generally met through use of electric geysers /heater which are very cheap owing to low upfront investment and is devoid of other prevailing barrier preventing commercialisation of the SWH technology.[19].
For retrofit across existing facility the baseline will be the existing hot water generation option (electricity or fossil fuel as applicable). For new construction the baseline option will be electricity which is the most suitable options for the residential establishment.
The dependency of SWH on the weather conditions and perceived risk (lack of awareness) associated with the SWH technology or process is too high to attract investment. The prevalent market related and technological barrier is further worsen by the higher initial investment cost as the capital expenditure for standard solar water heater system is prohibitively high in compared to the electricity heater or fuel based heating system. The CDM programme activity will facilitate wide spread penetration and dissemination of the technology among all the potential sectors of economy by introducing affordable financial instrument, maintenance option and increasing awareness level about the system.

Emission Reduction due to the Project Activity:

The solar water heating technology conceived as a part of the project activity uses the thermal content of the solar radiation to heat up water / thermic fluid in the solar water heating system. The water/ thermic fluid heated if not heated using solar energy would have used fossil fuel or electricity in the baseline scenario for the requisite thermal energy requirment. The use of fossil fuel or fossil fuel based grid power results in emission of green house gases. The use of solar water heater thus abates/ reduces fossil fuel consumption in comparison to the baseline scenario and thereby results in green house gas emission reduction.

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

Solar Water Heater

The Proposed CDM programme activity includes installation of technologically sound state of art and commercially available SWH technology that is approved by MNRE/ BIS. The SWH is designed to utilise solar radiation to heat up water/ thermic fluid. The solar water heating system to be conceived under the PoA can be:

1. Open loop Direct SWH system (without heat Exchanger) with Natural draft/ Thermo siphon or forced Draft.

[19] Solar Water Heating System- A Review of Global Experiences – Prepared by MNRE and REEEP – page no 15, (http://www.aeinetwork.org/reeep/doc/DIREC_Background.pdf) and
Barriers to the diffusion of Renewable energy technology – Dr. B. Sudhakar Reddy , Indira Gandhi Institute of Development research, http://uneprisoe.org/RETs/MaharashtraStudy.pdf (pg 21)

2. Closed Loop Indirect Solar water heating system – Solar water heating system heats anti freeze/ thermic fluid which later on transfers the heat to water/ other medium through heat exchanger.

Operating Principle

The Solar water heater works on the principle of absorption of solar radiation by black body. Solar energy is received on earth surface in form of radiation comprises mostly of the visible and infrared wavelength. The black body intercepting the solar radiation converts solar energy into heat which is transferred to the fluid. The process of heating of water/thermic fluid is either direct (open loop) or in direct (closed loop).
In direct type system/open loop system solar radiation absorbed by the collector is transferred directly to the water flowing through the collector. Heated water is collected in the tank which is insulated to prevent heat loss. Circulation of the water between the tank and the collector is either automatic due to the density difference between the hot or cold water by thermosiphon effect or forced circulation through use of pump.

In indirect type system/ closed loop system- solar radiation absorbed by the collector is transferred to the thermic fluid flowing through it. The thermic fluid line is physically separated from the hot water line and is connected via heat exchanger. The heat absorbed by the thermic fluid is transferred to the water via heat exchanger. In these systems, heat exchangers are installed to protect the system from hard water or from freezing temperatures in the cold regions. The water being heated in the collector passes through the heat exchanger and returns back to the collector, forming a closed loop.

System components

The typical solar water heater systems consists of
1. Insulated hot water storage tank
2. Collector (either of the type)
   - Flat plate collector
   - Evacuated Tube collector.
3. Hot and Cold water Pipes
4. Pump (if the system involves Forced Draft circulation)
5. Valves and Safety device
6. Insulating material
7. Fixation structure
8. Thermic fluid, heat exchanger (for indirect heating system)
9. Electric Backup
10. Water, Antifreeze liquid, thermic fluid
11. Thermometer (for commercial system as well as large residential SWH system)

Flat Plate Collector based solar water heater system

The flat plate collectors consist of an insulated outer metallic box covered on the top with glass sheet. Typically, a flat plate solar collector also includes absorber plate, flow passages, cover plate, and a weather-proof insulated casing. Absorber plate is made of copper, steel or plastic. Top surface of the absorber plate, which is exposed to the sun, is blackened with a paint having high absorption capacity for solar radiations. Amongst various coatings, black chrome is very popular in India and elsewhere. The glazing material to be used as cover should have high transmittance for solar radiations (0.3 – 2.0 μm)

and low transmittance for long wavelength radiations (≥ 2.0 μm). Toughened glass is most commonly used as cover plate, however, plastic materials have also been used[20]. The space between back and sides of the absorber and the box is filled with insulation to achieve loss coefficient not more than 5W/m^{2}C. Inside are blackened metallic absorber (which is coated on its sun facing surface with an absorbent coating, also called selective coating sheets) with built in channels or riser tubes to carry water. The absorber absorbs the solar radiation and transfers the heat to the flowing water. Flat plate collectors are specified on the basis of their area and are of commonly 1x2 m size.

Evacuated Tube Collector based solar water heater system

The metal fin-in tube configuration contains a selectively coated metal absorber plate placed inside a glass tube. Air is removed from the tube to create the vacuum. Heat is extracted from the absorber plate by circulating water through a copper pipe bonded to the absorber in U-shape. Glass to metal seals is required for maintaining the vacuum. The collector in this type of system is made of double layer borosilicate glass tubes evacuated for providing insulation between absorber and ambience. The outer wall of the inner tube is coated with selective absorbing material. This helps absorption of solar radiation and transfers the heat to the water which flows through the inner tube.

Figure 3: ETC based System

Figure 4: FPC based System

Storage tank

The hot water storage tank with the solar water heating systems is typically a double walled tank. The space between the inner and the outer tanks is filled with insulation to prevent heat losses. The inner tank is generally made of copper/stainless steel to ensure long life. The outer tank is made of stainless steel sheet, painted steel sheet or aluminium.

Minimum Technical Standard of SWH system to be considered under the CDM Programme Activity:

All the SWH installation to be conceived under CPA will either be BIS approved technology in case of FPC based system or MNRE approved system in case of ETC based system. Following are the General Requirement[21] specified by MNRE and will be followed for selection of system and its installation as a part CDM programme activity:

[20] http://www.solarwaterheater.gov.in/page.php?pid=65

[21] http://mnre.gov.in/file-manager/UserFiles/instructions_to_customers_of_solarwaterheaters.pdf

1. All the collectors will be south facing inclined at suitable angle to give best performance in winter[22]
2. There will not be any shadow falling on the collectors from nearby structures or of other collectors in front or back row.
3. Hot water pipe lines of any kind in colder regions will be fully insulated from the point of drawl of water from tank to delivery points. In other regions also care will be taken to avoid heat losses from pipelines.
4. System will be installed nearest to the point of hot water usage to avoid longer pipeline & higher heat losses.
5. Where water quality is bad either FPC based systems with Heat Exchanger or ETC based systems will be installed.
6. Air vent pipe, make up water and cold water tanks will be installed as required for smooth functioning of the system.
7. System will be well grouted/ clamped with collectors installed so as to enable it to sustain the highest wind pressure of that area.
8. There won't be any leakage observed in the system from tanks/ collectors/ pipelines

FPC Based Collector

1. The collector should be manufactured as per ISI standard
2. For 2 sq. m. of absorber area the size of the tank will be 100 litre in colder region and 125 litre for other regions (For natural draft based system). The capacity of the system will be determined based on the actual collector area in place and not on the volumetric capacity.

Evacuated Tube collector

Minimum of 1 ½ sq. m. of absorber area for 100 liter tank capacity system (For natural draft based system) accordingly, 14 tu**b**es of diameter: 47 mm & length: 1500 mm and 10 tubes of diameter 58 mm & length: 1800 mm will be required for each 0.100 m^3 per day (100 lpd) system. For higher capacity systems, the number of tubes calculated as per above could be slightly less. The actual area of the collector array will be determined based ont he number of tubes.

Forced Circulation system:

The forced circulation systems are solar water heater system that uses electrical pumps to circulate the water between collectors and storage tanks. The operation of the pump in the forced draft system is a controller based and operates either on the differential temperature basis or timer based. A forced circulation system can be included in both open /closed loop system and ETC/FPC based system.

Cumulative Capacity of SWH systems under CPA

Cumulative capacity of the SWH system installation to be conceived under each CPA under the PoA will be limited to 64,000m^2 for small scale CPA and 21,428 m^2 for micro scale CPA. The maximum number of beneficiaries under each CPA will be determined based on the number of beneficiary with cumulative collector capacity within aforementioned threshold limit for small scale/micro scale category.

[22] As per the approved methodology the orientation of the solar collector shall be ±45 of due equator and tilt+15 to -25 degrees of latitude

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

The eligibility criteria for inclusion of a SSC-CPA in a PoA are framed in accordance to "Standard for demonstration of additionality, development of eligibility criteria and application of multiple methodologies for programme of activities"" version 1 Annex 3 EB 65 and is as follows:

Sl.No	Eligibility Criteria as per the requirement of "Standard for demonstration of additionality, development of Eligibility criteria and application of multiple methodologies for programme of activities"	Eligibility Criteria for inclusion of a SSC – CPA in the PoA	Documents to Be reviewed
1.	The geographical boundary of the CPA including any time-induced boundary consistent with the geographical boundary set in the PoA	It is to be reviewed on whether the physical and geographical boundary of the SWH systems including its points of usage considered under the CPA to be included in the titled PoA is within the political boundary of India including its states and union territories. The check relates to review of the detailed address on where the solar water heater system is installed and specifically the state domicile. The boundary of the PoA is described in Section A.4.1.2 of the CDM-SSC-PoA-DD.	1. Installation report from manufacturer / supplier/dealer with detailed address of the location 2. Acceptance test report carried out by the CMe
	CME Assessment : ☐ Yes ☐ No		
2.	Conditions that avoid double counting of emission reductions like unique identifications of product and end-user locations (e.g. programme logo)	Solar water heating system to be covered under the CPA is to be provided with a unique identification number (UID). This unique identification number as against each system will be tagged along/ written/ marked with/on the SWH system or its component to avoid double counting. An agreement will be entered into amongst the CME and beneficiary/end user, with or without the involvement of aggregating agencies pertaining to the roles and responsibilities of agencies and the revenue (from sales of CER) sharing mechanism. The agreement will also include detailed information of the end user and self -declaration by the end user/beneficiaries to ascertain that SWH system conceived under the titled CPA for which the end user agreement is being signed is not included to	1. Acceptance test report with Photograph of the SWH system and the UID 2. Agreement between end user and CME (the end user agreement will provide with end user level confirmation) 3. Declaration by the agency if any other than CME aggregating the installation under CPA to confirm that the beneficiary considered under the project activity.

		obtain CDM revenue as a part of other project activity and also under other CPA under the titled PoA. The identification number is linked to a database system containing information about the SWH system and the beneficiary. In addition to the beneficiary level information the name of manufacturer/ distributor/ supplier of each system will be incorporated in the database as an additional measure to prevent double counting. **CPA level confirmation** End use beneficiaries/Agencies other than CME aggregating Solar water heating system for consideration under a CPA will provide a written confirmation to the CME that the SWH system considered under the CPA has not been registered as a CDM project or as a CPA of another PoA. (where the CME is the aggregating agency such undertaking won't be required however the beneficiary level undertaking will be obtained.) **User level information** The user level information relating to name and address of the beneficiaries along with proof of identity if any will also be fed to the database to avoid repetition. As a part of the agreement the end user provides confirmation to the CME that the system was not considered as a part of other CDM project activity. **Database level assessment** Information related to each of participants agreement, unique identification number and installation document will be fed into the database and verified to ascertain that the same information is not repeated as a measure to avoid double counting. **Verification by the Nodal Agency** For the purpose of subsidy disbursement by MNRE, third party verification is carried out for each beneficiary by the agency itself or through third party agency on behalf of State Renewable Energy Development Agency /MNRE. Subsidy is disbursed only when MNRE is ensured about installation of the	4. Subsidy disbursement certificate issued by the SNA (applicable only for system availing subsidy)

		system. It is also worthwhile to mention that subsidy is disbursed to beneficiary only once for each system ensuring the authenticity of the information and uniqueness of the system. The documents submitted for the purpose of subsidy disbursement/subsidy disbursement documents will also be used to verify with the information presented in the end user agreement and assessment test report. Such verification will nullify the chances of double counting. In case MNRE or the state Nodal Agency discontinue with the subsidy then the described step will be ruled out from the assessment option. The information obtained from the above i.e. acceptance test report, end user agreement and documents for subsidy disbursement will be cross verified before imputation of information in the database to avoid repetition of the information inclusion. The database will be accessed by the CDM team to ensure that there has been no repetition of information about the SWH system. Moreover the unique identification number and data capturing software will ensure that same information is not submitted twice in the database. The above assessment will be followed to avoid double counting.	
	CME Assessment : ☐ Yes ☐ No		
3.	The specifications of technology/measure including the level and type of service, performance specifications including compliance with testing/certifications	For consideration of Solar Water Heater system under the component project activity (CPA) the CME will review the selected technology and installation protocol followed and confirm on whether the SWH system meet the specified standard • SWH system to be considered is either a flat plate collector (FPC) or evacuated tube collector (ETC) based technology. • The FPC based system complies with the technical requirement of BIS • The ETC based system complies with the technical requirement of MNRE • The accessories complies with the technical requirement guidelines of the Storage Tanks, Piping, Support structure should comply with Minimum	1. Installation report of the manufacturer with detailed system specification as required in the preceding section. 2. Undertaking from manufacturer relating to system being manufactured as per BIS / MNRE standard. 3. Acceptance test report to establish the baseline hot water system in use

		Requirements for installation of Solar Water Heating Systems in Field by MNRE 2September 2011 http://mnre.gov.in/pdf/minimum-technical-specicifications-SWHS.pdf • The SWH system is purchased from BIS approved manufacturers/supplier/ distributors for FPC based systems and from MNRE approved manufacturers/suppliers for ETC based systems. In case the SWH system is procured from supplier/ distributor other than BIS/MNRE approved manufacturer/supplier a third party certification (a single certification for similar model) relating to the system being manufactured as per BIS or MNRE approved specification should be produced. • The system is to be installed in residential or commercial establishment (commercial establishment also includes SMEs). • SWH system comprising of Evacuated tube collector must maintain vacuum insulation between absorber and ambient. • SWH system installed in commercial establishment and in large residential establishment (large residential system covers stand alone SWH system at residential establishment with stand alone array capacity more than 100m^2) includes temperature display (thermometer) on the solar preheat storage tank from where it can be easily interpreted by the intended users that water is being heated by solar energy. • SWH system in commercial establishment and large residential system (large residential system refers to SWH system with stand alone capacity of more than 100m^2) is to includes flow and temperature sensors (both inlet and outlet) to monitor the consumption rate and the temperature at which the water is actually utilised. (Residential SWH system categorised as small system will have monitoring system installed at sample site) • The SWH system is installed by retrofitting existing electric or fossil fuel based water	and confirmation over the installation standard followed.

		heating system or in new construction which includes - New facilities. - Existing facilities without the provision of water heating system. - Existing facility that requires capacity additions. - Replacement of failed solar water heating system. To confirm that SWH system is installed across residential establishment and eligible for consideration under stipulated energy saving method it is reviewed that SWH system – is used to heat water that is to be used for domestic purpose only. – is installed to serve one or more residence. - Has a maximum stand alone collector area of 100m^2 but limited to 8 m^2 per residential building. - The tilt and orientation of the solar collectors shall be +/- 45 of due equator and a tilt +15 to -25 degrees of latitude. - Possess thermal storage volume of at least 0.05 m^3 (50 litres) per square meter of collector area (for natural draft based system). - There must be no shading of the solar collectors between 10 am to 2 pm on the shortest day of the year at the time of installation. - Glazed collector must have at least one glass cover and be insulated on the sides and back to achieve a loss coefficient not more than 5 W/m^2C.	
	CME Assessment : ☐ Yes ☐ No		
4.	Conditions to check the start date of the CPA through documentary evidence	For each CPA it is to be confirmed that the start date is not prior to start date of global hosting of the programme of activates which is date on which the POA is published for global stakeholder's consultation. The start date of each CPA will be the earliest date of release of Purchase order/date of sales invoice for SWH system to be aggregated under each component project activity.	1. Purchase order /Installation certificate / Sales invoice

		The start date of installation of each system will be verified from the date of the purchase bill/invoice.	
	CME Assessment : ☐ Yes ☐ No		
5.	Conditions that ensure compliance with applicability and other requirements of single or multiple methodology/ies applied by CPAs;	A CPA to be included in the PoA shall meet the applicability conditions of the methodology AMS-I.J version 01 which are as follows • The SWH system installed under each CPA included in the PoA will comprise of installation at residential and commercial establishment. Residential SWH system are those that heats water to be used for domestic purpose only and has an maximum standalone capacity of 100m^2. System other than residential will be conceived under commercial category. The SWH system has / would displace electricity or fossil fuel that would otherwise have been used to produce hot water. An electric geyser are most prominent device to meet up low pressure hot water requirement and is conceived as the baseline option in residential and also commercial establishment. . • The SWH systems to be included in the CPA and considered under the PoA are either a retrofits type or across new construction. - In case of retrofit the SWH installation has replaced existing electric or fossil fuel based water heating system(s) in existing facility(ies); - In case of new construction project SWH system might be (i) installed in new facility(ies); (ii) installed in existing facility(ies) that, prior to the project implementation, do not have installed water heating systems; (iii) installed in existing facility(ies) which require water heating capacity expansions; or (iv) Replace of failed solar water heating system(s). . • Commercial SWH systems will include operational indicators which can be easily interpreted by the intended users of the systems and that water is being heated by solar energy. The minimum requirement	1. Acceptance test report for type of establishment (residential/ commercial), baseline system (for retrofit) 2. Installation report for system capacity 3. Meter specification: Meter used under system metering method. 4. Purchase order for thermometer for commercial system

		for such an indicator is a visible temperature display (thermometer) on the solar preheat storage tank. The thermometer does not require calibration. • To qualify as a small-scale project, the definitions in paragraph 4(d) in the "General Guidelines to SSC CDM methodologies" (version 17), or the related paragraphs in the latest version of the guidelines are applicable. Therefore the following points are applicable ✓ The aggregated installed collector area under the CPA in the PoA is less than 64,000 m^2 for small scale CPA and 21,428 m^2 for micro scale the CPA. • For residential SWH system opting for system based monitoring approach for emission reduction estimation and commercial SWH projects the hot water consumption rate and temperature at which the hot water is supplied to the load (that occur during the crediting period will be used to determine emissions savings. The consumption rate (and temperature) is the rate (and temperature) of water actually utilized (for example for personal washing or for an industrial process) and is not the rate (and temperature) at which hot water is produced, which may be greater than the rate (and temperature) of consumption. Apart from the above applicability criteria following will also be the criteria followed • The CPA will undertake emission reduction estimation in accordance to either system metering method or stipulated energy saving method. • For CPA estimating emission reduction using system metering method it shall be demonstrated that the energy savings are based on the hot water consumption • For CPAs using the stipulated energy savings method it has to be demonstrated that the average energy demand exceeds the stipulated energy savings of 450 kWh / year per m^2, as per section 10 (c) (iv) of AMS I.J. Moreover it shall also be ensured that the	

		average annual daily amount of water heated by the SWH system is less than or equal to the average annual, daily hot water demand. • For CPA using stipulated energy savings method it has to be demonstrated that the residential building where the SWH system is installed is not a temporary or seasonal housing. • The CPA is undertaking monitoring in accordance to paragraphs 13 and 14 of AMS I.J version 1. For the purpose of finalising the energy saving estimation approach the installation will be distributed in a manner under each CPA so that each CPA will follow a single monitoring approach: Type1: Residential SWH system with size of collector array per stand alone system less than or equal to $8m^2$. Such installation will use stipulated energy saving method. Type 2: Residential SWH system with size of collector array per stand alone system less than $100m^2$ and greater than $8m^{2.}$ Such installation will use system metering approach. However the metering will be carried out on sample basis. Type 3: Residential SWH system with size of collector array per stand alone system greater than $100m^2$ and commercial SWH system: Such installation will use system metering approach. However for this type of installation all the SWH system will be monitored. To finalise the calculation approach each type of installation considered under a CPA wont contain different installation type so only one type of emission reduction estimation approach i.e. either stipulated energy saving method or system metering method will be used and not a combination of either in any of the CPA.	
	CME Assessment : ☐	Yes ☐ No	
6.	The conditions that ensure that CPAs meet the requirements	The additionality is addressed to demonstrate that the CPA would not have occurred otherwise in absence of the CDM programme	1. Installation certificate to confirm the panel

	pertaining to the demonstration of additionality as specified in Section A above. The stipulated criteria under section A is as follows: Additionality shall be demonstrated by establishing that in the absence of CDM, none of the implemented CPAs would occur. • PoAs that consist of one or more microscale projects as CPAs shall include eligibility criteria derived from all the relevant requirements of the "Guidelines for demonstrating additionality of microscale project activities". • PoAs that consist of one or more small-scale projects as CPAs shall include eligibility criteria derived from all the relevant requirements of attachment A of Appendix B of the "Simplified modalities and procedures for small-scale CDM project activities".	of activity. The additionality is demonstrated at the PoA level**.** The additionality for the component project activity is being addressed at the PoA level both - for the CPA that are either to be developed under micro scale category and under small scale category. At the CPA it will only be assessed that the cumulative capacity of the SWH system considered under the CPA complies to the stipulated criterion/ condition based on which the project is determined as automatically additional. For CPA covering cumulative installation below 21,428m^2 the additionality at the CPA level will be assessed as per Guidelines for demonstrating additionality of Micro scale project activities EB 68 Annex 26, ver. 4. For CPA covering SWH installation in household and commercial establishment with cumulative installation aperture area of 64000m^2 the additionality will be demonstrated in accordance to "Guidelines On The Demonstration Of Additionality Of Small-Scale Project Activities" Version 9.	capacity in sq. metre. 2. Acceptance test report for technology. 3. Database and agreement for cumulative installation.

	• PoAs that consist of one or more large scale projects as CPAs shall include eligibility criteria derived from all the relevant requirements contained in the additionality section of the large scale methodologies	The PoA is small scale CDM Programme of activity and is not a large scale project and hence the condition is not applicable for the titled PoA or the CPA to be included under the PoA.	
	• The CME shall demonstrate that compliance with the additionality-related eligibility criteria set in the PoA design document will ensure that all the relevant additionality-related guidelines, tools or any requirements embedded in the methodologies are met.	The relevant tools used for demonstration of additionality is detailed out in section A.4 .3.	
	• For PoAs involving combinations of technologies/measures and/or methodologies, the eligibility criteria relative to each of them shall be proposed to demonstrate additionality. Types of	The PoA is framed on single technology/measure i.e solar water heater and hence the conditionality stipulated under paragraph 29(a) to 29(d) is not applicable.	

	combinations as indicated in paragraph 29(a) to 29(d) below shall be taken into account		
	CME Assessment : ☐ Yes ☐ No		
7.	The PoA-specific requirements stipulated by the CME including any conditions related to undertaking local stakeholder consultations and environmental impact analysis;	The information on Environmental Analysis is addressed in Section C of the PoA. The stakeholder's consultation will be carried out at the CPA level.	1. Stakeholders invitation documents 2. Stakeholders attendance sheet
	CME Assessment : ☐ Yes ☐ No		
8.	Conditions to provide an affirmation that funding from Annex I parties, if any, does not result in a diversion of official development assistance	The CPA's under the PoA will not receive any public funds resulting from diversion of ODA from parties included in Annex I to the convention. Self-declaration by the CME is provided to ascertain that there is no or won't be any diversion of the official development assistance for the purpose of the CDM program of activity.	Declaration by the CME over the issue of public funding and ODA
	CME Assessment : ☐ Yes ☐ No		
9.	Where applicable, target group (e.g. domestic/commercial/industrial, rural/urban, grid-connected/off-grid) and distribution mechanisms (e.g. direct installation);	The CPA will cover installation of residential and/or commercial SWH system Residential SWH system are categorised as SWH unit installed to heat water for domestic purpose only with a maximum stand-alone collector area of $100m^2$ Systems that are installed to suffice the hot water requirement for purpose other than domestic use are considered as commercial system. SWH system sufficing domestic hot water requirement and with size of collector array per stand alone system higher than $100m^2$ is categorised as commercial system.	Acceptance test report for beneficiary type.
	CME Assessment : ☐ Yes ☐ No		
10.	Where applicable, the conditions related to sampling requirements for a PoA in	Sampling Sample monitoring practice is conceptualised and incorporated in the following cases: a. CPA with more than one residential system	Third party report of the sampling

	accordance with the approved guidelines/standard from the Board pertaining to sampling and surveys;	with installed capacity over $8m^2$ and less than $100m^2$ are to opts for system metering method as an approach for estimating the energy saving with monitoring carried out across sample system. The energy saving for other non monitored system in the sample will be determined on the basis of energy saving across a statistically valid sample of the residence where the monitoring system is/will be installed. The sampling will be carried out in accordance with "Guidelines for sampling and survey for CDM project activities and program of activities". Version 2 EB 69 Annex 5. The sampling is determined in accordance to paragraph 15 of the methodology considering 90/10 confidence/precision level as sampling survey will be carried out on an annual basis. Since the technology and its usage pattern is of identical nature therefore Simple Random Sampling is be adopted. The number of sample system and the procedure for reliability check is detailed out in the subsequent section E.7 of the PoA DD. The distribution of the monitoring system will considered apportionting the 1. Type of installation – ETC/FPC 2. Under the broad technology category system will be selected on the basis of type of operation – Natural draft and forced draft 3. Under the broad technology category system will be selected on the basis of region However, all the manufactures/ suppliers of the SWH in this PoA must comply with MNRE/ BIS approved technical standards for the product. So there will not be any major technical difference across the manufactures, hence not considered for proportionate sampling.	
	CME Assessment : ☐	Yes ☐ No	
11.	Where applicable, the conditions that ensure that every CPA in aggregate meets the small-scale or micro scale threshold criteria	For CPA with aggregated installation of less than 21428 m^2 and covering installation at residential, community and SME, the project will be conceptualised under Micro scale CDM programme activity.	1. Installation certificate to confirm the panel capacity in sq. metre. 2. Acceptance test report.

	and remains within those thresholds throughout the crediting period of the CPA Where applicable, the conditions that ensure that CPA in aggregate meets the small-scale or micro-scale threshold criteria and remain within those thresholds throughout the crediting period of the CPA;	For CPA with cumulative installation of less than 64000m^2 and covering both residential and commercial SWH system will be conceived under small scale category.	
	CME Assessment : ☐ Yes ☐ No		
12.	Where applicable, the requirements for the debundling check, in case CPAs belong to small-scale (SSC) or micro scale project categories	De bundling check will be carried out at the CPA level based on the capacity of the stand alone SWH system conceived as a part of the CPA. In accordance to "Guidelines on assessment of debundling for SSC project activities" paragraph 10, If each of the independent subsystems/measures (e.g., biogas digester, solar home system) included in the CPA of a PoA is no larger than 1% of the small-scale thresholds defined by the methodology applied, then that CPA of PoA is exempted from performing de-bundling check. Based on the above, the 1% threshold limit for small scale CPA is 640 m^2 and micro scale is 214 m^2. If the subsystem included in the CPA is more than 640 m^2 under Small Scale or more than 214 m^2 under micro scale then de-bundling check will be carried out at the CPA level.	Declaration by CME over the issues confirming the de-bundling issues
	CME Assessment : ☐ Yes ☐ No		

The co-ordinating and managing entity will check each of the CPAs based on the eligibility criteria stated above and ensure that each CPA meets all eligibility criteria before inclusion in the registered 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 proposed PoA is a voluntary co-ordinated action launched by the Ministry of New and Renewable Energy (MNRE) under UNDP-GEF umbrella programme aimed at enhancing the penetration and accelerating the growth of SWH installation in the country. The initiative will also help in attaining the target cumulative installation of 20 million square metres by 2022 under JNNSM.

In spite of the financial and fiscal benefit from Ministry of New and Renewable Energy along with policy regulation and awareness towards promotion of solar water heater technology the cumulative installation of solar water heater technology till date is around 4.02% of the total cumulative potential in the country. Secondary literature revealed that the major barrier towards widespread non acceptance of the technology lies in its high initial cost, annual cost of operation and maintenance and lack of awareness, technological and weakness of the supply chain including trained manpower.

The PoA is launched to harness carbon credit revenue as an additional annual income stream for the program crediting period of twenty eight years with each component project activity having crediting period of ten years. Since the receipt of carbon credit revenue depends on the operation of the SWH system the beneficiary as well as the manufacturer/supplier will ensure proper operation of the system during its life time. As a part of the revenue sharing mechanism the CME will enter into a contractual agreement with each end user/ beneficiary by virtue of which the beneficiary has to continue with the existing installation without any modification. These rules out the possibility of the cumulative installation capacity crossing the threshold of 21,428m^2 for micro scale project and 64000 m^2 for small scale project.

Moreover the CME will ensure wide spread awareness generation and promotion of technology in course of stakeholders consultation programme during each CPA. Therefore the initiative will enhance the viability of the product which will result into a greater level of enforcement of the existing policy and regulation in the state or union territory with or without existing bylaw[23]. For the state that lacks policy regulation the PoA will enhance the level of implementation through voluntary approach by enhancing the financial viability.

As outlined in section A.4.2 above the additionality of the project including the component project activity is addressed at PoA level. Eligibility test will be carried out at the CPA level to ascertain that the CPA meets the stipulated additionality criteria based on which the additionality is established.

In accordance to guidelines of EB 68 Annex 26 and Annex 27 SWH technology conceived both under micro small scale and small scale category is considered under positive list of technology and thereby deemed to be additional subjected to its fulfilment of the stipulated criterion. In accordance to "Guidelines on the demonstration of Additionality of Small Scale Project activities" version 9 the additionality is demonstrated by establishing that the PoA would not be implemented in the absence of the CDM revenue. Also the PoA will lead to a greater level of enforcement of the existing mandatory policy/regulation.

The demonstration that the widespread implementation of solar water heater would not happened otherwise due to the existence of one or more of the barriers. Studies undertaken[24] in identifying the barrier preventing the penetration of SWH technology across domestic, commercial and industrial sector

[23] http://mnre.gov.in/Solar-water-heaters/status.pdf
[24] Barriers to Diffusion of Renewable Energy technologies by Dr. Sudhakar Reddy , Indira Gandhi Institute of Development Research , http://uneprisoe.org/RETs/MaharashtraStudy.pdf (Pg 40- 48)

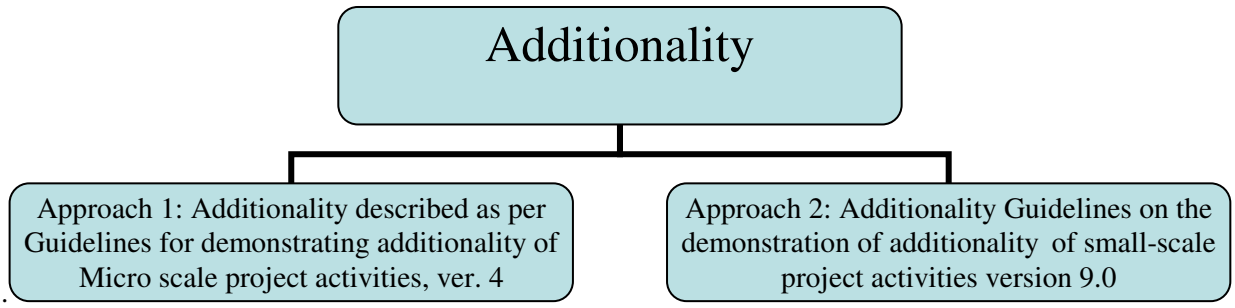
reveals barriers like lack of sufficient information in regard to the potential saving, environmental and social contribution and high initial cost. The same barriers are also portrayed in other studies[25] as the major lacuna behind the potential estimated and actual implementation of the technology i.e., the initial capital investment, uncertain saving and maintenance problem.
The major barrier other than stated above are highlighted and explained as follows The major barriers prevalent other than stated above are[26]:

1. Lack of awareness amongst the potential users.
2. Lack of capacity amongst the delivery/supply/service chains (including ESCOs) and technical competencies in undertaking maintenance.
3. Availability of SWHS products and components, along with capital cost.
4. Space availability to install the collectors (especially in industries and commercial establishments).
5. Efficacy of regulatory intervention

Thus carbon credit revenue will be used to for the following purpose

- Providing additional incentives to overcome the financial barriers. Additional incentives in terms of carbon credit revenue will be passed on to the beneficiaries to provide on with an affordable solution that will facilitate to overcome the aforementioned financial barriers.
- Supporting end user in selecting MNRE/BIS approved SWH system and accessories as a prerequisite for consideration under PoA.
- To address barrier due to technology and prevailing practice, the manufacturer/supplier will allow beneficiaries covered under the PoA to factor into operation and maintenance plan throughout the crediting period which will reduce the customer risk in terms of technological failure. Such initiatives are unavailable for other baseline options.
- Providing training to the end user on periodic and regular maintenance procedure
- The CME and its partner agencies (manufacturer/supplier) will undertake initiatives towards training of installers so as to facilitate effective installation and quality maintenance service.
- Wide scale promotion of the solar water heater technology will facilitate market development by means of awareness generation through stake holders consultation. Creating awareness about the product in order to enhance the acceleration of solar water heater market growth

Approach for demonstration of automatic additionality for the CPA
SSC-CPA will be considered to be additional subjected to its fulfilment of the following criterion outlined in section A.4.2



[25] Carbon finance and Solar water heating technology http://www.solarthermalworld.org/node/90 , and Solar Energy Info Kit" http://www.terienvis.nic.in/solar_energy_compendiumf.pdf

[26] Solar Water Heating System- A Review of Global Experiences – Prepared by MNRE and REEEP – page no 15-18 (http://www.aeinetwork.org/reeep/doc/DIREC_Background.pdf)

Approach I- Demonstration of Additionality of Microscale Project Activities

In accordance to the Guidelines for demonstrating additionality of Micro scale project activities, ver. 4 paragraph 2 project activities employing renewable energy technology below 5 MW and satisfies stipulated conditions (2.c) are eligible under Micro Small Scale Guidelines. In furtherance to the stipulated guidelines the clarification provided in "F-CDM-SSCwg ver 01 SSC_576" and foot note 9 of the guidelines confirms the applicability of solar water heater under micro scale guidelines.

In accordance to the clarification provided to the guidelines the maximum capacity for thermal energy will be limited to $15MW_{thermal}$. As per the "General guidelines to SSC CDM Methodologies" version 17 an using the factor of $700Wth/m^2$ the aggregated threshold capacity of SWH system that can be considered under the micro scale category is 21,428 m^2 of collector area of SWH system. Therefore project activity meeting the specified criteria stipulated under paragraph 2.c of the guidelines is considered to be additional. The conditions stipulated are

1. SWH systems cumulating to a capacity less than 21,428 m^2 under a CPA is eligible to demonstrate additionality under Micro Scale Guidelines . CPA's under the PoA remain under the thresholds of micro small scale project activities during each year of the crediting period which will be ensured by assessment of the eligibility criteria for inclusion of a CPA in the PoA
2. Each of the independent SWH system is smaller than/ equal to 1500kW. Threshold limit of 1500kW of electrical load resembles to $4500kW_{th}$. Conceiving the conversion factor of $700Wth/m^2$ the maximum threshold capacity is estimated as 6428 m^2.
3. The system is to be installed in households/communities[27] /small and medium enterprises (SMEs).

SWH installation satisfying above criteria will be considered to be automatically additional in accordance to guidelines of Micro Scale Activity[28].

Approach II: Additionality demonstrated as per "Guidelines on the demonstration of additionality of small-scale Project activities" Version 9.0 EB 68 annex 27.

The guidelines specifies list of positive technology and project activity types that are defined to automatically additional. As per paragraph 2.c of the specified guidelines solar water heater technology is conceived as positive technology. The CPA covering SWH installation with maximum installation limiting to a cumulative aperture area of 64,000 m^2 is conceived under the approach subjected to fulfilment of the following specified criteria:

1. Project activities solely composed of isolated units
2. Users of the technology/measure are households or communities or Small and Medium Enterprises (SMEs)
3. Size of each unit is no larger than 5% of the small-scale CDM thresholds i.e. 3200 m^2

Therefore it can be concluded SWH installation covered under the CPA and fulfilling the aforesaid condition are conceived to be additional.

[27] Communities: communities" of consumers may for example include households, commercial facilities such as shops, public services/buildings and small, medium and micro enterprises (SMMEs);

[28] http://cdm.unfccc.int/filestorage/c/x/JG45UHWQCZLIME1RF0T3BXOAY286N9.pdf/eb68_repan26.pdf?t=Rmx8bThhb2s5fDDYB3LsbKUKp0ajTz8YIsJp

Thus all the SWH installation under any CPA of the PoA will abide by the stipulated criterion under the "Guidelines on the demonstration of additionality of small-scale Project activities" or the Guidelines for demonstrating additionality of Micro scale project activities , it is concluded that all the CPA conceived under the PoA is determined to be automatically additional.

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

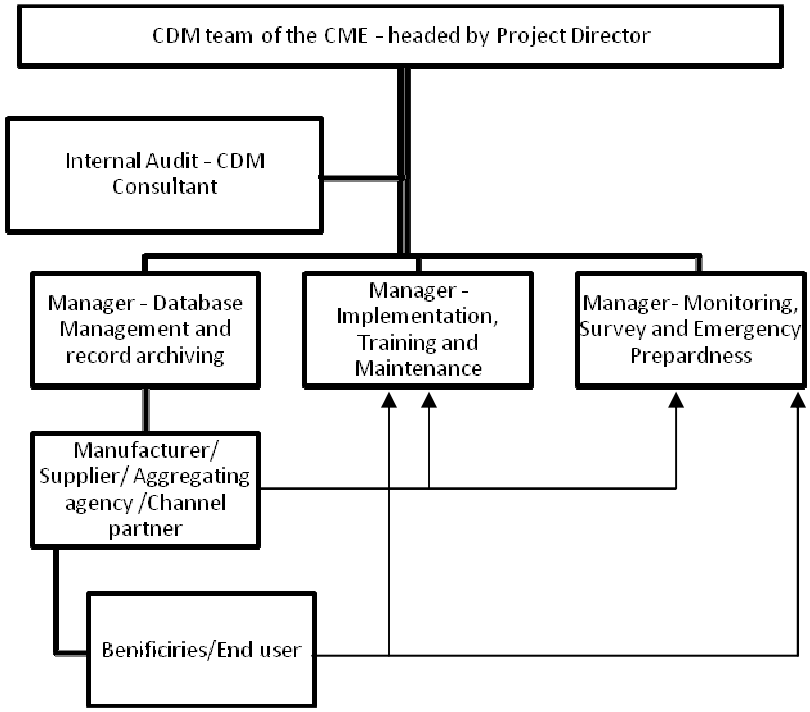
A.4.4.1. Operational and management plan:

The operational and management arrangements for the implementation of the PoA will be executed by the coordinating / managing entity (CME) supported by manufacturer/supplier/aggregator and CDM consultant whose specific role and responsibilities are explained in the subsequent section. M/s G K Energy Marketers Pvt. Ltd will be the sole coordinating entity of this PoA and will act as a CME for all the CPAs under the PoA.

The implementation of the project activity i.e. installation of SWH will be facilitated by manufacturer / supplier of solar water heater or even other channel partners (specified in Figure 1 above). The CME being a MNRE approved manufacturer can also act as a supplier of SWH to the project activity. As indicted in figure 1 above the SWH installation can be aggregated be the CME/beneficiaries or end users co-operative/ channel partner / manufacturer/ supplier of SWH. However for all the CPA under the PoA M/s G K Energy Marketers Pvt. Ltd will continue as a CME and will therefore hold the CER right and act as a focal point of all communication with the DNA, DOE , UNFCCC and the buyer for the purpose of validation, registration and verification of the CDM project along with transaction of the CER.

The following section also explicitly indicates the proposed plan for implementation and record archiving procedure, management of monitoring, facilitating survey, training, maintenance plan and emergency preparedness. The operational and management arrangement will include the following components:

Figure 5: Operational and Management structure



The roles and Responsibilities of the CME will be as follows:

1. Facilitating signing of end user agreement
2. Creation and maintenance of database of user. The detailed information to be included in the database is presented in the table below. The database management and record archiving team will be headed by the CDM team manager and will facilitate development, updating and management of database.
3. Undertake review that the SWH installation conceived under the CPA meets the eligibility criteria for inclusion of the CPA in the PoA as per section A.4.2.2.
4. The CDM team of the CME will undertake following task to assess the credibility of the system for inclusion
    - To co-ordinate with the partner agency (manufacturer/supplier) for the SWH system to ensure proper system and its component selection, installation and operation of the SWH system.
    - Undertake acceptance test to judge the technical specification of the system and implementation parameters of the SWH system based on the criteria specified in A.4.2.2. of the PoA DD.
    - To review that the beneficiary has signed the end user agreement with the CME and transfer the CER right to the CME.

    On satisfactory fulfilment of the above specified conditionality the CDM team will present the interim report to the top management of CME, who after subsequent verification of information will allow the participation of benificiries aggregated under the CPA for a PoA.
5. Facilitating periodic maintenance of SWH.

6. Facilitating monitoring of CDM PoA , assessment test to judge the sanctity of implementation, training and maintenance, annual inspection/survey
7. Facilitating inclusion of CPA in the registered PoA through assessment of the eligibility criteria as mentioned in section A.4.2.2 of the PoA DD and avoids double counting.

The End users or beneficiaries will be responsible for-

1. Continual use of the SWH system
2. Facilitating undertaking periodic maintenance
3. Destroy and sell out exiting water heating system that are used in the baseline. Before the sell out of the baseline water heater the CME or its associate / project partner will ensure of the demolition/ breaking of the existing heater so that it cannot be reused but can only be recycled.
4. Supporting CDM monitoring team in undertaking monitoring
5. For reporting any problem with the operation of SWH system to a partner agency in the location, whose contact details are being provided to the end user for submission of complaint.

The manufacturer/Supplier/aggregating agency will be responsible for-

1. Supporting CME/CDM team in database archiving
2. Facilitating periodic maintenance and database update as and when required
3. Facilitating installation as per the specified technical standard of MNRE/BIS

Database Management

A record keeping for each CPA under the PoA,

The co-ordinating and managing entity will facilitate implementation of the PoA. The CME will work along with the CPA owner or the agency aggregating the installation to maintain and update the database containing information of each installation covered under the CPA. As a part of the PoA and subsequent CPA the CME will maintain an electronic as well as manually archived database comprising of the following information against each CPA.

ID. No	Description of the Identification number	Details	Additional information Components	Purpose
1	Unique ID number	The unique ID is assigned to each SWH system on its consideration as a part of the CPA	✓ Name of the CPA Installers	Unique assignment of each system to a CPA

Separate copies of the following documents will also be maintained by the CME both as hard copy in addition to being electronic archive.

Database content

Sr. No	Documents title	Component

1	Beneficiary information	✓ Name of the beneficiary (family name - first name – middle name) ✓ Father/husband name ✓ Specific identification number (Electoral ID/Passport / other ID approved by Central/state government) ✓ Telephone number ✓ Address along with PIN code (to confirm whether the SWH is within the Geographical area of the PoA) ✓ Type of Establishment (Residential/commercial). In case of residential an confirmation whether the building where the SWH is installed is the primary residence of the household that requires hot water round the year ✓ Confirmation that the SWH system is newly installed and not sourced from other activity
2	Installation record	✓ Date of installation ✓ Type of SWH system (ETC/FPC) ✓ Operating Principle (natural/forced draft) ✓ System operation (direct/ indirect heating system) ✓ Serial no/ Model number of the SWH system ✓ Name of the SWH system manufacturer/distributor ✓ SWH collector area ✓ Storage tank capacity ✓ Compliance with BIS/MNRE standard (yes/no) ✓ Retrofit / new construction project ✓ Baseline fuel for retrofit project ✓ Tilt and orientation ✓ Confirmation that there is no shading on the system
3	Acceptance Test	✓ Date of acceptance test ✓ Confirmation of successful completion of acceptance test
4	Inspection Protocol	✓ Operation and maintenance schedule ✓ Confirmation that the system was in operation during the biannual inspection ✓ Periodic inspection report synopsis based on the inspection of the sample group indicating the proportion of SWHs that were operating during the crediting period ✓ Emergency maintenance - The CPA owner for any problem with SWH system distributor will report to the CME about the problem and its treatment to ensure the number of systems in operation in any CPA

All data and records will be maintained for at least two years after the end of the crediting period and after last issuance of the last CPA. The field level information about the beneficiary obtained from system documents, acceptance test report, end user agreement and document used for subsidy disbursement will be imputed into the database either directly or via web interface. Database synchronisation will be facilitated in case agency other than the CME is aggregating the installation and facilitating aggregation of SWH under the CPA and is located at far of distance from CME's office. Dedicated database software will be used for information archiving in a secure hosted environment. Imputing of relative information in the database will be carried out by the CDM Team of the CME and verified by the Database manager. The database will be maintained in the central server located at the office of the CME. The information can be drawn from the database and used for purpose of reporting.

The hard and electronic copies of the relevant documents as used for development of the database will be archived and preserved by the CME at its office. The recording and archiving procedure of information and the relevant documents will be reviewed in course of internal audit carried out by the CDM consultant. Discrepancies if any will also being reported to the top management for corrective action. Relevant data capture, verification and storage procedures will be followed in maintaining the data to ensure its accuracy, validity and completeness.

System to prevent double counting

A system/procedure to avoid double accounting will be carried out in accordance to point 2 of the eligibility criteria mentioned in section A.4.2.2.

Debundling Check

The SSC-CPA included in the PoA is not a de-bundled component of another CDM programme activity (CPA) or CDM project activity as given in point 12 of Section A.4.2.2.

Procedure to ensure end user participation for CDM project

The provisions to ensure that those end user participating in the CPA are aware of and have agreed that their activity is being subscribed to the PoA;

M/s G K Energy Marketers Pvt. Ltd will act as the CME for all CPA. The CME will sign bipartite/ tripartite agreement with the end user those who have installed the SWH system . As a part of the contractual agreement the party implementing the CPA and its end user will pass on the right of CER claim to the CME and CME will be the focal point under the modalities of communication. And the CME will explicitly define the CER revenue sharing mechanism in consultation with the end user as a part of the agreement. The CME will explain in details to the end user about the CDM and the benefit that the end user is supposed to receive during the signing of agreement.

Training and Capacity building

The CME along with the consultant will impart training and undertake capacity development exercise of the CDM team to facilitate implementation and monitoring procedure. The training and capacity building exercise have two facets indicated below:

1. Training on the technical standard and issues relating to the SWH system so that the team can undertake the acceptance test , check the system installation as against the technical standard specified in the eligibility criteria, facilitate operation and maintenance and training end users.
2. Training on database preparation, update and record archiving. The database recorded in the main server will maintained at the CME office.
3. Training for undertaking monitoring (either cent percent or on a sample basis).
4. Estimation of the energy gain and emission reduction, preparation of periodic monitoring report.

The training will be facilitated at the office of the CME. The record of training relating to the persons trained, topic, attendance sheet and the training manual will be archived by the CME. Any new members of the CDM team of the CME will only be allowed to undertake the task of monitoring if only undertaken training.

A.4.4.2. Monitoring plan:

The CME will verify each CPA individually and will implement a procedure to allow the DOE to verify the emission reductions for each individual CPA. A database will be maintained by CME for each CPA and the PoA. The database includes information described in the section A.4.4.1 above to prevent double counting. The CME will also undertake the following activity as a part of the monitoring:

Acceptance Test: Installation covered under CPA will be inspected within three months of installation to ensure correct installation and operation of the system. Acceptance testing shall be documented and confirm system operation as per design specifications, and change-of-operating modes over a range of typical operating conditions. The installation date of each SWH system shall be recorded.

During inspection each of the end user will get an induction on operational aspects and information booklet of the SWH system. The information booklet will possess contact details of the dealer/installer responsible for the PoA for the particular area where queries and complains can be submitted in case of any malfunction. In case of a failure of SWH system the end user will contact identified dealer/installers in the contact address provided in the information booklet. The dealer/installer will record the problem, the solution as well as how long the installation was out of operation and submit to the CMA in prescribed format. Complaints will be recorded in the data base system.

Monitoring approach
In accordance to Annex I of the methodology the selection of the monitoring approach and its basis is specified as follows:

Monitoring approach

System Designation	Large	Small	Very Small
Size of the collector (cumulative area of the array per standalone system)	Any Size	100 m^2	8 m^2
Expected number of installation per project	One or more	Many	Very many
Loads that can be supplied	Residential/Commercial	Residential	Residential
Monitoring method	System metering	System metering	System metering/stipulated Energy saving method
Monitoring system	Monitoring will be carried out for all installation	Monitoring will be carried out for a representative sampling	In case system metering approach is considered Monitoring will be carried out for a representative sampling

Therefore in accordance to above

1. The choice of Stipulated energy saving method is to be used for all the residential system which are very small i.e. each independent system is ≤ 8 m^2.

2. For Large systems 100% system metering will be used for all collector systems with ≥100m^2 which include residential and commercial establishment
3. For small systems in residential complex (between 8m^2 and 100m^2) system metering will be used for representative sample and for commercial 100% metering will be used.

For residential SWH system:

(i) For residential system using stipulated energy saving method of monitoring emission reductions it is to be demonstrated that the SWH system are operational and in compliance with manufacturer-required maintenance procedures, on annual basis during the crediting period. As a procedure for annual inspection, following the inspection and acceptance testing during the year of project installation, the inspections will be carried out across each year.

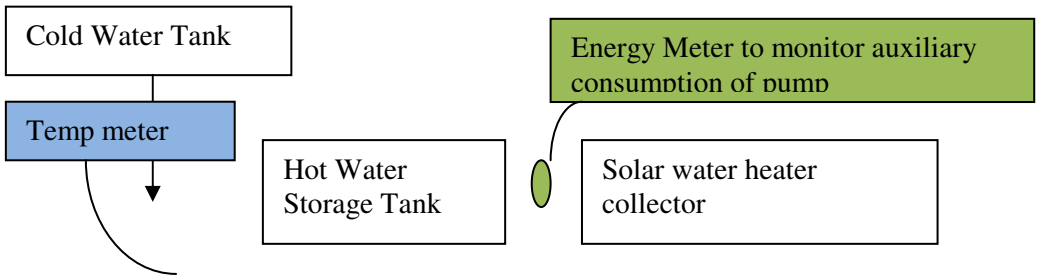
(ii) For CPA covering more than one residential SWH system with individual stand alone capacity of less than 100m^2 but more than 8 m^2 and is using system monitoring approach for estimation of emission reduction , system metering based monitoring will be carried out across representative sample in accordance to the approved baseline methodology AMS.I.J.
The energy saving from all of the systems will be determined from a statistically valid sample of the residence where the monitoring system will be installed. The sampling will be carried out in accordance with "Guidelines for sampling and survey for CDM project activities and program of activities"

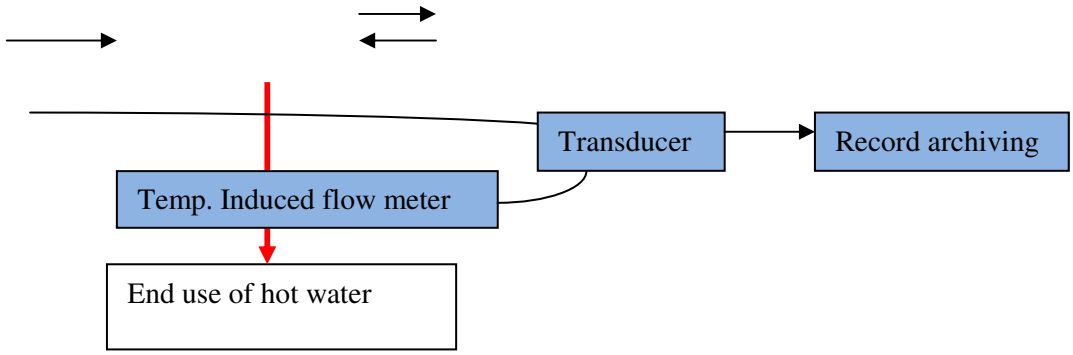
(iii) In case the SWH system installed in Commercial establishment or residential system with area per stand alone system more than 100m^2 metering will be carried out across all system installed,

(iv) The system metering will include monitoring of

- ✓ Energy content (flow rate integrated with temperature difference between inlet and outlet water temperature) of consumed/utilized hot water delivered by the project SWH system(s) to the end uses measured and integrated, at least once every minute by a thermal meter and recorded on a daily basis.
- ✓ Estimate the energy content to be used at least on a monthly basis, to calculate the equivalent amount of energy that would have been consumed in the baseline system.
- ✓ Fossil fuel and/or electricity use of project SWH system is continuously measured and recorded at least monthly for electricity, liquid or gas fuels and daily for solid fuels.
- ✓ The difference between baseline and project fossil fuel, and/or electricity consumption is calculated as the energy content of the consumed/utilized project hot water delivered by the project SWH system divided by the efficiency of the baseline water heating system minus any fossil fuel and/or electricity consumption of the project system
- ✓

For SWH where monitoring will be carried out in accordance to system metering method the schematic design of the monitoring system is presented as follows:





Data to be monitored and frequency

Data monitoring

Monitoring Parameter	Positioning of the Monitoring Equipment	Monitoring Frequency
Inlet water temperature	The temperature transduces will be inserted in the cold water line.	The temperature (impulse) will be measured at the interval of one reading in every minute and recorded on daily basis averaged on monthly basis.
Outlet water temperature	The temperature transduces will be inserted into hot water line before the point of usage.	The temperature (impulse) will be measured at the interval of one reading in every minute and recorded on daily basis averaged on monthly basis
Flow meter	The flow meter will be inserted on the pipe line supplying hot water to the usage point	The impulse will be recorded on and when water flows across the outlet. .The Flow meter will only read once the water is used. The cumulative flow meter reading will be archived on an annual basis.
Energy Meter (used only in case of forced draft system)	Between the pump and grid	The energy consumption relates to the auxiliary consumption of electricity by the pump for forced draft systems. The energy consumption will be recorded continuously and archived on a monthly basis

(v) The coordinating/managing entity opts for a verification method that does not use sampling but verifies each CPA to ensures that no double accounting occurs and that the status of verification can be checked anytime for each CPA;

The calculation of emission reduction for commercial systems requires total monitoring of all SWH system as per para 10.b. For the ease of verifications, any CPA envisaged under the commercial systems will not be clubbed with residential systems which are less than 100 m^2 and vice versa or any of the CPA won't be clubbing the monitoring approaches like stipulated energy saving method, system metering

method (sample basis) and system metering method (total).CME will prepare a monitoring report for each CPA for a monitoring period in order to estimate the emission reductions attributed to each CPA. Record maintaining procedures will be implemented to ensure that each monitoring period data set can be transparently attributed to its corresponding CPA and SWH, preventing any chances of double counting.

Monitoring approach for small solar water heater system across residential establishment

In accordance to paragraph 10.b.5 of the methodology residential establishment with small SWH system with capacity of individual system higher than $8m^2$ and lower than $100m^2$ can opt for system metering method across representative sample. In case system metering approach is selected for monitoring at residential establishment (with each SWH system size less than $100m^2$) monitoring will be carried out at a representative residential establishment to determine the average heat gain. The detailed sampling plan is outlined in section E.7 of the PoA DD

Training

The training will be imparted to the following entities in following way-

Entity	Objective of training	Trained by	Onset	Frequency
Household	1. Operational procedure 2. Scheduled maintenance 3. Itemised recording and reporting	CDM team	After installation	Once
CDM team	1. Database management and record archiving 2. Undertaking Monitoring, Recording and archiving 3. Facilitating implementation in accordance to the specified standard 4. Undertaking acceptance test 5. Training of end user over the operation procedure, scheduled maintenance 6. Preparation of monitoring report 7. Facilitating monitoring 8. Undertaking emergency preparedness	CDM Consultant and Top Management of the Project participant	On registration	Once in a year

Quality Assurance and Quality Control of monitoring activities –

Top management of the CME (M/s G K Energy Marketers Pvt. Ltd) shall be responsible for QA/QC which will include monitoring of accurate and transparent record keeping, monitoring and evaluation so that all supporting documentation and records for the project will be easily accessible for spot checking and cross referencing by a third party agency. Top management of the project participant will ensure quality control of the monitoring activities in order to guarantee of records and to confirm absence of double-counting in any form. The CME will ensure that, the detailed beneficiary level database and the project database will be up to date and the latter is representative of the most recent definitions of clusters.

Internal audit will be carried out on six month basis by the CDM consultant and will include -

1. The internal review will be carried out in every six month for compliance check in accordance to the manual.
2. Non conformity if noted will be reported and brought into the notice of the top management and measures will be undertaken to ensure that required compliance is met.
3. Training on the monitoring if felt by the auditor will be imparted to the CDM team.

Calibration intimation:

Since each PoA will have large number of monitoring system in place a system is being developed to impute the calibration information in relevant software. The calibration expiry period will be programmed into the online database and monitoring system will warn the respective relevant team on the issues of the calibration expiry period being approaching one quarter (3 months) prior to the expiry period of the calibration of each of the equipment's.

Emergency Preparedness

In case the malfunction of the system is reported the technical team will immediately attend and facilitate fault rectification.

Uncertainty in Data Monitoring

Sl. No	Data to be monitored	Metering	Emergency Preparedness
1	System functioning	-	As a part of the emergency preparedness plan following parameters will be monitored and archived 1. Date of identification of Problem/fault 2. Date on which the problem is rectified 3. Duration of non-functioning
2	Inlet water temperature	Temperature transducers	All the meter will be scheduled to be checked once in every quarter , and if it is observed during inspection by the monitoring team that the meter is not in function, the amount of heated water during the period won't be taken for emission reduction estimation. The meter will be replaced immediately after inspection
3	Outlet water temperature	Temperature transducers	All the meter will be scheduled to be checked once in every quarter , and if it is observed during inspection by the monitoring team that the meter is not in function, the amount of heated water during the period won't be taken for emission reduction estimation. The meter will be replaced immediately after inspection
4	Water usage	Flow meter	All the meter will be scheduled to be checked once in every quarter , and if it is observed during inspection by the monitoring team that the meter is not in function, the amount of heated water during the period won't be taken for emission reduction estimation. The meter will be replaced immediately after inspection

5	Electricity consumption	Energy Meter	In case the meter is found to be faulty during quarterly inspection the total amount of electricity consumed will be estimated based on the capacity of the pump and operational hours estimated from the flow data.

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

The SWH to be installed and aggregated as CPA under the proposed PoA will not be based on any public funding nor will result into diversion of Official Development Assistance.

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

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

The Start date of the PoA will be the date of webhosting the PoA which is 17/03/2012.

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 ☐

Environmental analysis is undertaken at the PoA level, since the type of impacts of all CPAs will be identical

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

Environmental performance forms an integral part of the project proponent's endeavour towards sustainable development. After conceiving the project activity, it was found that the PoA won't have any negative impacts on the environment or the people of India. There won't be any negative transboundary impacts on other countries also.

The project is designed to use the solar radiation available on the earth surface to heat up water and thereby reduces consumption of fossil fuels, either directly or indirectly via decreasing the consumption of grid-based electricity. The project will therefore reduce emissions of greenhouse gas emission as well as emissions of other air pollutants (SOx, NOx, and particulate matter resulting from combustion of fossil fuel directly for thermal energy generation or for generation of electricity in the grid connected power plant). The project returns benefits to the local, regional and global environment in various ways –

Air Pollution mitigation:

- Reduced additional GHG emission related to power production and other pollutant like oxide of sulphur, nitrogen, and suspended particulate matter.
- Reduced emission from extraction and transportation of fossil fuel.

Water Pollution mitigation:

- Waste water generation from the power plant which is being discharged results in considerable amount of water pollution.

Soil Pollution Management:

- No ash generation and therefore no associated pollution of the top soil.

Disposing mechanism: Baseline system

The electric heaters are manufactured out of steel/plastic body, and copper/metallic coil. When the beneficiaries plan to dispose of the system the beneficiary will initially carry out dismantling of the system in a manner that it can be reused followed by sell out of the dismantled parts. The parts will be sold out to recyclable agencies which can thereafter be supplied to the manufacturing industries for being used as a raw material for the production since all the components of electric geysers/fossil fuel heaters are recyclable. The revenue from the sale of the baseline equipment will be nominal as the sell out will be carried out for the dismantled parts only. However the revenue from the sale of the dismantled baseline system will be retained by the beneficiary.

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),:

Notification Published Dtd. September 14, 2006 in the Gazette of India, Extraordinary, Part-II, and Section 3, Sub-section (ii) Ministry Of Environment And Forests lists project activities that are required to undertake environmental impact assessment studies[30]. The proposed project of installation of Solar Water Heater does not fall under the list of activities requiring EIA. As such EIA will not be required to be conducted for the installation to be covered under the CPA.

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 ×

Since each CPA will focus on certain geographical area and with the envision that the market scenario of the product might vary across time it was decided to undertake the consultation at the CPA level. Moreover the consultation programme is also aimed at imparting awareness among the stakeholders on the product and its impact towards sustainable development and therefore the consultation was decided to be undertaken at the CPA level.

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

[30] http://envfor.nic.in/legis/eia/so1533.pdf

Not applicable. Local stakeholder's consultation will be undertaken at CPA-level.

D.3. Summary of the comments received:

Not applicable. Local stakeholder's consultation will be undertaken at CPA-level.

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

Not applicable. Local stakeholder's consultation will be undertaken at CPA-level.

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:

All CPAs in this PoA will use baseline and monitoring methodology AMS-I.J. "Solar water heating systems"[31], version 01.

Type	Version	Title	Sectoral Number
I.J	1 (EB 60)	Solar Water Heating Systems(SWH)	1

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

Applicability Criteria	Justification of Choice
This category comprises the installation of residential solar water heating (SWH) systems and commercial SWH systems for hot water production. The SWH systems displace electricity or fossil fuel that would otherwise have been used to produce hot water.	The SWH system to be considered under CPA to be included in the PoA will comprise of the installation of solar water heater systems across residential and commercial establishment (the definition of Residential and commercial solar water heater will be as per AMS-I.J solar water heating systems (SWH), version 1) for hot water production. Such installation will only be eligible to be considered under the PoA. The installation of solar water heater will displace use of electricity or other fossil fuel that were used or would have otherwise be used as baseline options for obtaining

[31] http://cdm.unfccc.int/methodologies/DB/GX9DV8QFP9X8BNR5GI1UUJD55EJ03A

	hot water in the project scenario. As per the publication by MNRE[32] most of the hot water demand in various application in our country is met through conventional energy that is electric geysers running largely on grid power followed by natural gas based heating system. Therefore it can be concluded that the SWH system considered has /will displace fossil fuel/ electricity that would otherwise being used to produce hot water.
1. There are two types of projects included in this category: retrofits and new construction. For the purposes of defining baselines and other requirements the following definitions apply a. Retrofit projects are SWH project(s) that replace existing electric or fossil fuel based water heating system(s) in existing facility(ies); b. New construction projects are: (i) SWH project(s) installed in new facility(ies); (ii) SWH project(s) installed in existing facility(ies) that, prior to the project implementation, do not have installed water heating systems; (iii) SWH project(s) installed in existing facility(ies) which require water heating capacity expansions; or (iv) Replacement of failed solar water heating system(s). This methodology is applicable if it is shown (as per paragraph 8) that for new construction projects, conventional electric or fossil fuel based water heating system(s) would have been installed in the absence of the project activity.	SWH system to be covered/aggregated under the component project activity (CPA) and to be included in the PoA will involve installation following either or all of the options a. Retrofit project: Existing facilities where the SWH will replace existing electric or fossil fuel based water heating system. b. New construction where SWH systems will be installed at new facility (ies). c. New construction where SWH systems will be installed in existing facility(ies) that, prior to the project implementation, do not have installed water heating systems; d. New construction where SWH systems will be installed in existing facility(ies) which require water heating capacity expansions; e. New construction where SWH systems will be installed in existing facility(ies) where it will replace failed solar water heating system(s) As per the MNRE article cited in the justification of the above applicability criteria most of the hot water demand in various application in our country is met through conventional energy that is electric geysers running on largely fossil power or natural gas based heating system. The fact is also substantiated by the separate study by Dr. Sudhakar Reddy in the titled publication "Barrier to Diffusion of Renewable energy technologies" available at http://uneprisoe.org/RETs/MaharashtraStudy.pdf . From both the above literature it can be concluded that conventional electric based water heating system would have been installed in absence of the project activity.
Commercial SWH systems shall include operational indicators that may be easily interpreted by the intended users of the	Each of the Commercial SWH system and large residential solar water heater system (with capacity higher than 100 m2) considered under the CPA in the PoA will

[32] Solar Water Heating System- A Review of Global Experiences – Prepared by MNRE and REEEP – page no 5, (http://www.aeinetwork.org/reeep/doc/DIREC_Background.pdf)

systems and that indicate that water is being heated by solar energy. The minimum requirement for such an indicator is a visible temperature display (thermometer) on the solar preheat storage tank. The thermometer does not require calibration.	possess a temperature indicator in the tank which is easily visible by the beneficiary to interpret that water is being heated by solar energy.
To qualify as a small-scale project, the definitions in paragraph 4(d) in the General Guidelines to SSC CDM methodologies" (version 15), or the related paragraphs in the latest version of the guidelines are applicable.	The aggregated installed thermal energy generation capacity under each CPA of the PoA will be limited to 45 MW thermal which is equivalent to the 64,000 m^2 of the collector area using a conversion factor of 700Wth/m^2 in accordance to paragraph 4(d) of the "General guidelines to SSC CDM methodologies" For CPA conceived under Micro scale guidelines the aggregated installed thermal energy generation capacity under each CPA of the PoA will be limited to 15 GW thermal which is equivalent to the 21,428 m^2 of the collector area for consideration considering 700 Wth/m^2 of aperture area of glazed flat plate or evacuated tubular collector.
For residential and commercial SWH projects the hot water consumption rate and temperature at which the hot water is supplied to the load (for example, 40 litres per day at 40°C), that occur during the crediting period are used to determine emissions savings. The consumption rate (and temperature) is the rate (and temperature) of water actually utilized (for example for personal washing or for an industrial process) and is not the rate (and temperature) at which hot water is produced, which may be greater than the rate (and temperature) of consumption.	For CPA covering residential establishment with SWH system with stand alone capacity of 8m^2 for individual residential apartment Stipulated Energy saving method approach will be used for estimation of emission reduction and the system won't be metered. For system not covered under the above guidelines system metering method will be used. Flow meter and temperature sensors will be installed that can monitor flow rate integrated with temperature difference between the inlet and outlet water temperature. The Temperature of the hot water to be monitored will be the temperature at which the hot water is utilized.

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

As defined in AMS.I.J the spatial boundary of the project activity comprises of the physical and geographical boundary of all solar water heating system along with all accessories including the point of usage/establishment which consumes the heated water generated by the SWH system. The project boundary for CPA under the PoA also includes the national electricity grid from which electricity is sourced in the baseline scenario. The greenhouse gas that will be reduced because of the any CPA is CO_2. CPA will either replace/reduce electricity or fossil fuel consumption used in the baseline scenario for providing hot water.

	Source	Gas	Included?	Justification / Explanation
Baseline	**Emission from**	CO_2	Included	This consists of the major source of Green house gas

	combustion of fossil fuel in power plant for electricity generation			emission from use of electricity/combustion of fossil fuel.
		CH_4, N_2O	Excluded	Excluded for simplification
Project Emission	**Emission from Combustion of electricity**	CO_2,	Included	Emission due to consumption of electricity for operation of pump or other auxiliaries in forced draft system.
		CH_4, N_2O	Excluded	Excluded for simplification
Leakage	**The Project is a new installation** **For Retrofit system**	CO_2, CH_4, N_2O	N/A	For those systems installed under the project activity which are new, leakage is not considered. Since the baseline water heating system (for retrofit cases) that were existent at the time of installation will be dismantled or destroyed at the time of SWH installation the leakage due to baseline equipment is neglected.

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

For retrofit projects, the baseline system(s) are the operating water heating system(s) and fuel source (fossil fuel or electricity) that were used prior to the use of the SWH system under the project activity.
The options used for obtaining low pressure hot water requirement are detailed as follows. The alternative includes options that can be used for obtaining low pressure hot water for the purpose of residential and commercial application are:

a. Continuation of use/ installing new Electric Geysers/heaters
b. Continuation of use/proposed use of immersion rod type electric heaters
c. Fuel oil based Hot water generation option
d. Gas(LPG) based hot water generation option
e. SWH without CDM.

There are neither any policies nor regulation that prohibits any of the option identified step above as all the options identified in the step above are in compliance with mandatory legislation and regulations.
As per the Publication by MNRE [33] most of the hot water demand in various applications is met by heating water through conventional energy, that is, electric geysers running on largely fossil power or natural gas based heating systems. Since the system to be installed will be for low pressure application and the requirement of hot water is scattered for a wider period the option of coal or wood based thermal energy generation is not selected as a baseline option. Moreover the use of wood based water heating

[33] Solar Water Heating System- A Review of Global Experiences – Prepared by MNRE and REEEP – page no 5, (http://www.aeinetwork.org/reeep/doc/DIREC_Background.pdf)

boiler for the purpose of water heating is more restricted as felling of firewood is prevented by the forest policy in many states and there is also a demand supply gap in the availability of fuel wood in the country. On the other hand the use of coal is much more polluting and is used mainly in the industrial boiler only for generation of high pressure and high temperature steam located at industrial/commercial establishment. Moreover the rising cost of fuel oil and LPG[34] because of the revoking of subsidy by the government is a major hurdle in use of same as medium for water heating.
From the relevant secondary literature it is evident that electric heater are the most plausible choice for obtaining low pressure hot water requirement in residential and commercial establishment and the most suited replacement options. Therefore electric heaters are considered to be the baseline scenario for new construction scenario. The ever increasing price of the fuel oil and the availability of LPG is a constraint and therefore not conceived as the baseline option.

Moreover barrier analysis is not required as all the CPAs are coming under positive list of projects as per EB68 Annex 27 guidelines.

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

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

As outlined in Section A.4.3 above the additionality is established at the PoA level and is detailed out in section above**.** The additionality is established using following approaches and the CPA to be conceived under the PoA will abide by the following criterion outlined under the approach.
Approach A: Guidelines for demonstrating additionality of micro scale project activities (EB 68 Annex 27)
Approach B: Guidelines on the Demonstration of Additionality of Small-Scale Project Activities (EB 68 Annex 28)

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

The CPA to be considered for inclusion in the PoA considering the fulfilment of the criteria stipulated below:
Since the additionality of the PoA is established at the Program level therefore the CPA to be conceived for inclusion under the PoA should satisfy the stipulated criterion based on which the program is demonstrated to be automatically additional. The criterion for both the approaches are:

a. For CPA conceived as micro scale activities:. Following Section E.5.1, / A.4.3 the CPA should aggregate cumulative installation with total collector area being less than 21,428 m^2 and meets up the other criterion including the type of beneficiary and individual capacity. The ex-ante estimation of total collector area size of each CPA is examined in the CPA-DD

[34] http://mospi.nic.in/mospi_new/upload/Energy_Statistics_2012_28mar.pdf (pg 69-70)

b. .Guidelines on Demonstration of Additionality of Small Scale Project Activities version 9.0. Following Section E.5.1, / A.4.3 the CPA of the PoA is additional if the total collector area covered under a CPA is less than 64,000 m^2 and the project meets up the stipulated criterion including the type of beneficiary and individual capacity. The ex-ante estimation of total collector area size of each CPA is examined in the CPA-DD

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

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

Estimation of Emission reduction will be carried out in accordance to procedure outlined between paragraph 9 to 11 of the approved small scale methodology AMS-I.J version 1.

For Retrofit projects:

Emission reductions will be calculated as the energy savings that result from the project implementation multiplied by an emission factor for the electricity and/or fossil fuel displaced in the baseline scenario.

For New construction projects:

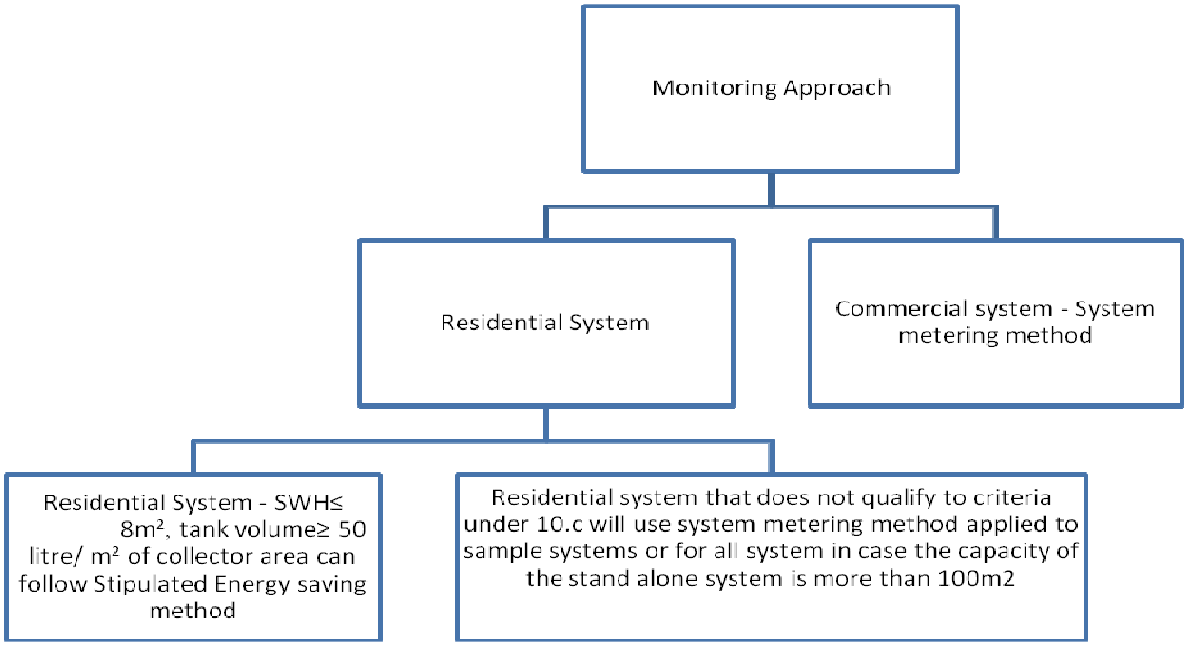
Emission reductions will be calculated as the energy savings that result from the project implementation multiplied by an emission factor for the grid electricity.

Energy saving from the Project activity

Energy saving that result from the project implementation shall be determined using one of following methods depending upon the SWH system considered:

a. System metering method
b. Stipulated Energy saving method

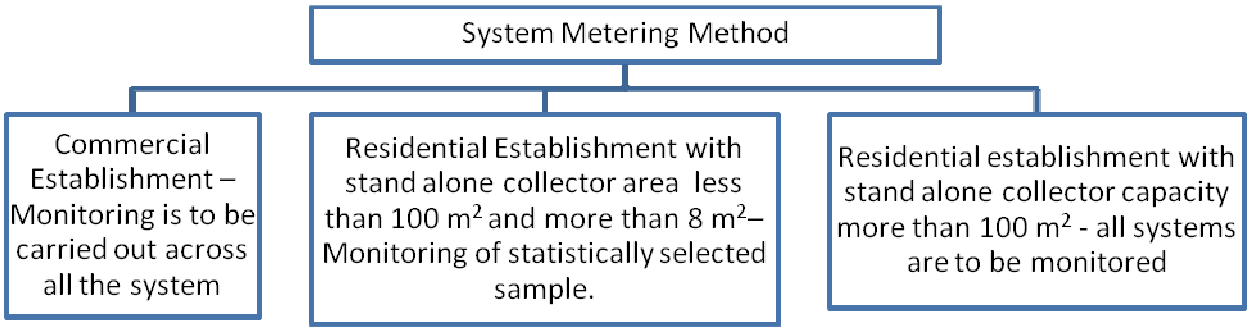
Monitoring Decision tree



Stipulated Energy saving method will be applicable in case of SSC-CPA that meets the following criteria:

a. Applicable to residential SWH system projects that displace electricity for water heating.
b. Individual solar collector area per system is less than or equal to eight square meters per residential unit *(e.g. eight square meters for a single family residence or 32 square meters for a four unit apartment building)*
c. For each installed SWH it is determined whether it "the average annual, daily amount of water heated by the SWH systems is less than or equal to the average annual, daily hot water demand for a typical installation." So that based on the criteria the energy saving per unit area of collector can be fixed.
d. There will be no shading of the solar collectors between 10 am to 2 pm on the shortest day of the year at the time of installation.
e. Glazed collector must have at least one glass cover and be insulated on the sides and back to achieve a loss coefficient not more than 5 W/m^2C.
f. Evacuated tube collector must maintain vacuum insulation between absorber and ambient.
g. The tilt and orientation of the solar collectors shall be +/- 45 of due-equator and a tilt +15 to -25 degrees of latitude.
h. Thermal storage volume (preheat tank volume) is at least 0.05 m^3 50 litres per square meter of collector area;
i. The stipulated energy savings values are applied according to paragraph 10 (c) (i) and (ii).
j. The stipulated energy savings are multiplied by the emission factor for grid-based electricity.

System metering method will be applicable to SSC-CPA that meets the following criteria:



a. In case the approach is applied for domestic installation and more than one SWH system is installed in the project the energy savings from all of the systems can be determined from a statistically valid sample of residences where the systems are installed. The sampling will be carried out in accordance to "Guidelines for Sampling and Surveys for CDM Project Activities and Programme of Activities" EB 69 Annex 5

b. The monitoring system will monitor the Energy content (flow rate integrated with temperature difference between inlet and outlet water temperature) of consumed/utilized hot water delivered by the project SWH system(s) to the end users within the boundary is measured and integrated, at least once every minute by a thermal meter and recorded on a daily basis. This energy content, will be estimated on at least a monthly basis and is to be used to calculate the equivalent amount of energy that would have been consumed in the baseline system to heat an equivalent amount of useful hot water.
Amount of Energy for a particular period will be determined as a product of the total mass of the hot water supplied to the end user, specific heat and the temperature difference of the inlet and outlet.

c. Electricity if used for the operation of auxiliaries will be monitored continuously measured and recorded at least monthly.

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

Emission reductions calculation

$ER_y = BE_y - PE_y - LE_y$

Where

ER_y - Emission reductions in year y (tCO_2e)
BE_y - Baseline emissions in year y (tCO_2e)
PE_y - Project emissions in year y (tCO_{2e})
LE_y -Leakage in year y (tCO_{2e})

For Stipulated Energy Saving Method

According to AMS I.J (paragraphs 9) "Emission reductions of CPA will be calculated as the energy savings that result from the project implementation multiplied by an emission factor for the electricity and/or fossil fuel displaced."
Moreover paragraph 11 of the methodology states that displaced electricity can include technical grid losses (transmission and distribution) for the grid serving the locations where the project SWH system(s) are installed. Since the region wise value of T&D loss is not available default value of 10% as proposed in the methodology is considered.

$BE_y = EF_{CO2\ ELEC,\ y} \times ELS_y / (1 - TDL)$

Where
BE_y = Baseline emissions in year y (t CO_2)
$EF_{CO2\ ELEC,\ y}$ = Carbon emission factor for grid-based electricity in year y (tCO_2 / MWh)
TDL = Transmission and distribution losses (%)
ELS_y = Electricity savings in year y (MWh)

Approach to be used for ex-ante estimation of emission reduction under Stipulated Energy Saving Method:

Procedure for Ex-ante estimation of emission reduction

Parameters	**Value**	**Unit**	**Reference**
Energy saving/annum	450	kWh/yr/m^2	A default value of 450 kWh/year/m2 is conceived for the purpose of Ex-ante estimation of emission reduction considering year round application of solar water heater. For the purpose it will be ensured that none of the installation conceived under the project activity is installed in temporary and seasonal housing. [35]
Grid Emission Factor NEWNE region	0.9215	tCO_2/MWh	Calculated based on CEA Database Version 7.0, http://www.cea.nic.in/reports/planning/cdm_co2/cdm_co2.htm
Grid Emission Factor Southern region	0.8427	tCO_2/MWh	Calculated based on CEA Database Version 7.0, http://www.cea.nic.in/reports/planning/cdm_co2/cdm_co2.htm
Baseline Emission - NEWNE	0.415	tCO_2/yr/m^2	

[35] The solar water heater system installed at permanent residential establishment will only be conceived under the CPA. Moreover it is worthwhile to note that the hot water in the household are not only used for the purpose of bathing but also for washing cloths, cooking and washing utensils , in such scenario it can be well concluded that the demand of hot water in the household will continue throughout. as per the secondary literature by MNRE (http://mnre.gov.in/file-manager/UserFiles/brief_swhs.pdf) a 100 LPD (2 sq.m) capacity solar water heater system can save an annual electricity consumption of 1500 kWh i.e. 750 kWh/sq. m for FPC based system and 1000 kWh/sqm for ETC based system which is more than the project case.

Baseline Emission - South	0.379	$tCO_2/yr/m^2$	
Total Installation - NEWNE	X1	m^2	Installation in square metre of SWH under NEWNE grid region needs to be imputed
Total Installation - South	X2	m^2	Installation in square metre of SWH under southern grid region needs to be imputed
T&D loss	10%		
Baseline Emission - NEWNE	0.415* X1	tCO_2/yr	Calculated as a Product of Baseline Emission – NEWNE and Total Installation - NEWNE
Baseline Emission - South	0.379* X2	tCO_2/yr	Calculated as a Product of Baseline Emission – South and Total Installation - South
Baseline Emission	0.415* X1+0.379* X2	tCO_2/yr	Calculated as a Sum of Baseline Emission – NEWNE and Baseline Emission - South
Project Emission	0	tCO_2/yr	Since the system to be conceived under the Stipulated Energy Saving Method will be natural draft system the project emission is considered to be nil
Leakage Emission	0	tCO_2/yr	All the system to be considered under the Project activity will be a new one and it will be ensured that the existing system is dismantled /destroyed
Emission Reduction	0.415* X1+0.379* X2-0-0	tCO_2/yr	$ER_y = BE_y - PE_y - LE_y$

For System Metering Method:

System metering approach where applied for estimation of emission reduction across commercial and residential system will include metering to monitor the heat gain. For residential system with standalone collector area more than $8m^2$ and less than $100m^2$ will undertake monitoring at stipulated sample site whereas residential system with standalone collector area more than $100m^2$ will undertake monitoring across all the system. For new installation electricity will be conceived as the baseline fuel where as for retrofit system the actual baseline fuel will be considered.

For sampling approach (Residential SWH system with standalone collector area between 8 m^2 and 100 m^2)

The Energy supplied will be estimated

EG_d = Energy content of the consumed/utilised hot water per annum/$m^{2.}$

$EG_d = M \times Cp \times \Delta t$

Where
M= Average mass flow rate of water per m^2 of collector area per annum of all the sample monitored system. The model calculation is given as below.

Monitored System	**A1 (X1 m^2)**	**A2 (X2 m^2)**	**-**	**An (Xn m^2)**
Monthly Recorded Flow	*Consistent Volumetric units*	*Consistent Volumetric units*	*Consistent Volumetric units*	*Consistent Volumetric units*
Jan	J1	J2		Jn
Feb	F1	F2		Fn
--				
Dec	D1	D2		Dn
Total	M1=(J1+F1+---+ D1)	M2=(J2+F2+---+ D2)		Mn=(Jn+Fn+---+ Dn)

Note: Where A1, A2—An the SWH system across which the flow meter are installed and X1, X2—Xn are the capacity of the solar water heater in m^2. The volume of water monitored across the flow meter multiplied by the density gives the total mass of the water used.

M = (M1/X1 + M2/X2 + ...+ Mn/Xn)/n
Where n is the total number of sample size to be monitored.

Δt = Average of the difference between inlet and outlet temperature (as per the recording) The model calculation is given as below.

Monitored System	A1	A2	-	An
Temp Difference	*Degrees centigrade*	*Degrees centigrade*	*Degrees centigrade*	*Degrees centigrade*
Jan	J1	J2		Jn
Feb	F1	F2		Fn
--				
Dec	D1	D2		Dn
Average	A1t = (J1+F1+---+D1)/12	A2t = (J2+F2+---+D2)/12		Ant = (Jn+Fn+---+Dn)12

Note: Where A1, A2—An the SWH system across which the temperature sensor are installed

Δt = (A1t+ A2t+-----+Ant)/n.

Cp = Specific heat capacity of water. (1Kcal/Kg/°C fixed ex ante)

The average mass of water used across the sample system, the average temperature rise and the specific heat is used to estimate the annual heat gain across the sample system per unit area of the collector.

Therefore Emission reductions $ER_y = BE_y - PE_y - LE_y$

Where BE_y = Baseline emissions in year y (t CO_2)

But $BE_y = EF_y \times EG_d \times A$

EF_y = CO_2 emission factor/ Grid emission factor for fossil fuel /Electricity replaced .

EG_d = Energy content of the consumed/utilised hot water per annum/m^2
A = Installed collector area in m^2

PEy = Project emission due to auxiliary consumption (operation of the pump in forced draft system, else Project emission is zero)

But $PE_y = EG_{A,\,y} * EF_{A,y,}$

Where $EG_{A,\,y}$ is the overall electricity consumption of pumps used for forced draft system in the year y and $EF_{A,y}$ is the grid emission factor for the respective grids from which the pumps draws it electricity.

The overall electricity consumption is estimated by $EG_{A,y}$ = Average Electricity consumed by the pump for one m^2 in the proportionate sample systems using forced draft system in kWh/m^2 ($EG_{Av,\,FD}$)* Total collector area in m^2 employing forced Draft system

LE_y = Leakage emissions which is zero as all the system to be considered under the project activity will be a new one and it will be ensured that the existing system is dismantled /destroyed

For System Metering Method: (Commercial systems and residential systems more than or equal to 100 m^2)

Energy content of the consumed/utilised hot water for the n^{th} system in m^{th} month
$EG_{d,\,n,m} = M \times Cp \times \Delta t$

Where
M= the mass flow of water (monthly recording)
Δt = Average of the difference between inlet and outlet temperature (monthly recording)

$BE_{y,n,m} = EF_y \times EG_{d,\,n,m}$

$BE_{y,n,m}$ = Baseline Emission for the n^{th} system in m^{th} month (t CO_2)

EF_y = CO_2 emission factor/ Grid emission factor for fossil fuel /Electricity replaced

The total baseline Emission BE_y for the year Y will be sum of all calculated $BE_{y,n,m}$.

Therefore Emission reductions $ER_y = BE_y - PE_y - LE_y$

PEy = Project emission due to auxiliary consumption (operation of the pump for forced draft system), else it is zero)

$PE_{y,n} = EG_{A,\,y,n} * EF_{A,y,}$
Where $PE_{y,n}$ is the Project emission due to auxiliary consumption of the nth system using forced draft, $EG_{A,\,y,n}$ is the overall electricity consumption of pumps used for nth system using forced draft system in the year y and
$EF_{A,y}$ is the grid emission factor for the respective grids from which the pumps draws it electricity

Thus PE_y is the sum of all $PE_{y,n.}$

LE_y = Leakage emissions which is zero as all the system to be considered under the Project activity will be a new one and it will be ensured that the existing system is dismantled /destroyed

A detailed approach for ex-ante estimation of emission reduction calculation is presented in the CER sheet.

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

Data / Parameter:	**$EF_{CO2\ ELEC,\ y}$ (OM) - NEWNE**
Data unit:	tCO_2/MWh.
Description:	Operating Margin refers to the average CO_2 intensity of existing stations in the grid.
Source of data used:	Obtained from the CO_2 Baseline Database for the Indian Power Sector" (Version 7.0) published by Ministry of Power Central Electricity Authority.
Value applied:	NEWNE is 0.9842 tCO_2/MWh (including import).
Justification of the choice of data or description of measurement methods and procedures actually applied :	The database is an official publication of the Central Electricity Authority, Government of India for the purpose of CDM baselines in the country.
Any comment:	The data is used for Ex ante estimation of emission reduction. The Factor will be fixed and will be used for ex-post estimation of emission reduction.

Data / Parameter:	**$EF_{CO2\ ELEC,\ y}$ (OM) -SG**
Data unit:	tCO_2/MWh.
Description:	Operating Margin refers to the average CO_2 intensity of existing stations in the grid.
Source of data used:	Obtained from the CO_2 Baseline Database for the Indian Power Sector" (Version 7.0) published by Ministry of Power Central Electricity Authority.
Value applied:	Southern Region is 0.9516 tCO_2/MWh (including import).
Justification of the choice of data or description of measurement methods and procedures actually applied :	The database is an official publication of the Central Electricity Authority, Government of India for the purpose of CDM baselines in the country.
Any comment:	The data is used for Ex ante estimation of emission reduction. The Factor will be fixed and will be used for ex-post estimation of emission reduction.

Data / Parameter:	**$EF_{CO2\ ELEC,\ y}$ (BM)- NEWNE**
Data unit:	tCO_2/MWh.
Description:	The build margin reflects the average CO_2 intensity of newly built power stations that will be (partially) replaced by a CDM project.
Source of data used:	Obtained from the CO_2 Baseline Database for the Indian Power Sector"

	(Version 7.0) published by Ministry of Power, Central Electricity Authority
Value applied:	NEWNE is 0.8587 tCO_2/MWh.
Justification of the choice of data or description of measurement methods and procedures actually applied :	The database is an official publication of the Central Electricity Authority, Government of India for the purpose of CDM baselines in the country.
Any comment:	The data is used for Ex ante estimation of emission reduction. The Factor will be fixed and will be used for ex-post estimation of emission reduction.

Data / Parameter:	**$EF_{CO2\,ELEC,y}$ (BM) -SG**
Data unit:	tCO_2/MWh.
Description:	The build margin reflects the average CO_2 intensity of newly built power stations that will be (partially) replaced by a CDM project.
Source of data used:	Obtained from the CO_2 Baseline Database for the Indian Power Sector" (Version 7.0) published by Ministry of Power, Central Electricity Authority
Value applied:	Southern Region is 0.7338 tCO_2/MWh
Justification of the choice of data or description of measurement methods and procedures actually applied :	The database is an official publication of the Central Electricity Authority, Government of India for the purpose of CDM baselines in the country.
Any comment:	The data is used for Ex ante estimation of emission reduction. The Factor will be fixed and will be used for ex-post estimation of emission reduction.

Data / Parameter:	**$EF_{CO2\,ELEC,y}$ - NEWNE**
Data unit:	tCO_2/MWh.
Description:	The combined margin is the weighted average of the simple operating margin and the build margin. The combined emission factor is estimated as a summation of 50% of operating margin and 50% of build margin emission factor.
Source of data used:	Estimated in accordance to "Tool to calculate the emission factor for an electricity system" Version 02.2.1
Value applied:	NEWNE is 0.9215 tCO_2/MWh
Justification of the choice of data or description of measurement methods and procedures actually applied :	The database is an official publication of the Central Electricity Authority, Government of India for the purpose of CDM baselines in the country.
Any comment:	The data is used for Ex ante estimation of emission reduction. The Factor will be fixed and will be used for ex-post estimation of emission reduction.

Data / Parameter:	**$EF_{CO2\,ELEC,y}$ -SG**
Data unit:	tCO_2/MWh.
Description:	The combined margin is the weighted average of the simple operating margin

	and the build margin. The combined emission factor is estimated as a summation of 50% of operating margin and 50% of build margin emission factor.
Source of data used:	Estimated in accordance to "Tool to calculate the emission factor for an electricity system" Version 02.2.1
Value applied:	Southern Region 0.8427tCO_2/MWh
Justification of the choice of data or description of measurement methods and procedures actually applied :	The database is an official publication of the Central Electricity Authority, Government of India for the purpose of CDM baselines in the country.
Any comment:	The data is used for Ex ante estimation of emission reduction. The Factor will be fixed and will be used for ex-post estimation of emission reduction.

Data / Parameter:	**TDL**
Data unit:	%
Description:	Transmission and distribution loss
Source of data used:	Default value specified in the methodology AMS-I.J
Value applied:	10%
Justification of the choice of data or description of measurement methods and procedures actually applied :	The date is default value specified in the methodology.
Any comment:	N/A

Data / Parameter:	**EF_y**
Data unit:	tCO_2/TJ
Description:	Carbon emission factor of fossil fuel replaced.
Source of data used:	IPCC Default recent values at the time document submission. (MR or CPA DD)
Value applied:	-
Justification of the choice of data or description of measurement methods and procedures actually applied :	Due to lack of reliable project specific data IPCC default value is used
Any comment:	The value will be recent values.

Data / Parameter:	**Thermal Storage volume for SWH - FPC based system**
Data unit:	m^3 of water per sq.m of collector area
Description:	The above factor refers to the minimum thermal storage volume in metre cube per square metre of flat plate collector area.
Source of data used:	Methodology

Value applied:	0.05
Justification of the choice of data or description of measurement methods and procedures actually applied :	As per technical standard specified by MNRE (http://mnre.gov.in/file-manager/UserFiles/instructions_to_customers_of_solarwaterheaters.pdf) a tank size of 0.1 m^3 (100 Litre) for 2sq.m capacity absorber in colder region and 0.100 m^3 (125 litres) for other region for FPC based system. However to have an uniformity 0.1 m^3 (100 Litre) per 2 square metre collector area is conceived
Any comment:	N/A

Data / Parameter:	**Thermal Storage volume for SWH – ETC based System**
Data unit:	m^3 of water per sq.m of collector area
Description:	The above factor refers to the minimum thermal storage volume in metre cube per square metre of Evacuated tube collector area.
Source of data used:	Methodology
Value applied:	0.06667
Justification of the choice of data or description of measurement methods and procedures actually applied :	As per technical standard specified by MNRE (http://mnre.gov.in/file-manager/UserFiles/instructions_to_customers_of_solarwaterheaters.pdf) ETC a tank size of100 litre is recommended for collector of 1.5 sq.m area.
Any comment:	N/A

Data / Parameter:	**Specific heat (cp)**
Data unit:	Kcal/Kg ^{0}C
Description:	The data refers to the heat required by a unit mass of a substance to raise the temperature by one degree also called the heat capacity of the substance.
Source of data used:	http://hyperphysics.phy-astr.gsu.edu/HBASE/thermo/spht.html
Value applied:	1 kcal/kg ^{0}C
Justification of the choice of data or description of measurement methods and procedures actually applied :	The data has been used to calculate heat value of water coming out of the Solar water heater tank.
Any comment:	N/A

Data / Parameter:	ρ_{water}
Data unit:	kg/l
Description:	The above parameter refers to the mass of the matter per unit volume.
Source of data used:	http://en.wikipedia.org/wiki/Density
Value applied:	0.98 kg/l
Justification of the choice of data or description of measurement methods	The value has been used to calculate the mass of the water used for the SWH system.

and procedures actually applied :	
Any comment:	N/A

Data / Parameter:	η_{BL}
Data unit:	%
Description:	The above parameters refer to the efficiency of the baseline system used for generation of hot water.
Source of data used:	Methodology
Value applied:	90%
Justification of the choice of data or description of measurement methods and procedures actually applied :	The methodology suggests the use of efficiency of baseline equipment. It is the most conservative approach and as such adopted for estimation.
Any comment:	N/A

Data / Parameter:	**Stipulated energy saving**
Data unit:	kWh/m^2/year
Description:	The above parameters refers to stipulated energy saving values
Source of data used:	Methodology AMS-I.J version 01
Value applied:	450 when it can be demonstrated that the facility is having substantial hot water consumption demand year round.
Justification of the choice of data or description of measurement methods and procedures actually applied :	The value is applicable to residential SWH system projects that displace electricity for water heating.
Any comment:	N/A

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

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

For any SSC-CPA to be included into the PoA following are the aspects to be monitored in accordance to AMS-I.J.

Data / Parameter:	**Total Collector area in operation under a CPA**
Data unit:	m^2
Description:	Amount of collector area in m^2 considered under the component project activity. Each SWH system should be identifiable against specific ID number.
Source of data to be	Database maintained by CME and based on the sample survey if the CPA uses

used:	more than 30 systems (as per sampling guidelines else if it less than 30, all systems need to be sampled) of less than or equal to 8 m^2 collector area.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	1. Maximum installed capacity of 21,428 m^2 in case the project activity is conceived under Micro scale guidelines. 2. Maximum installed capacity of 64,000 m^2 in case the project activity is conceived under small scale activity
Description of measurement methods and procedures to be applied:	The total amount of installation entered into the database against specific CPA ID and system ID will be cross verified to avoid double counting and summed up.
QA/QC procedures to be applied:	The system to be covered under any CPA will be identified on the basis of the unique ID and agreement with the Project Proponent.
Any comment:	NA

Data / Parameter:	**Number of People in each residential unit**
Data unit:	Number
Description:	The number of people in a particular residence will be estimated to assess the demand and verify that average amount of water heated up is less than the demand of hot water.
Source of data to be used:	Agreement between the end user and the CME and based on sample survey if the CPA uses more than 30 systems (as per sampling guidelines else if it less than 30, all need to be sampled) of less than or equal to 8 m^2 collector area.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	4 person against 0.100 m^3 per day (100 lpd) system
Description of measurement methods and procedures to be applied:	The database and the agreement will be verified for the information
QA/QC procedures to be applied:	The information of the number of individual dwelling in a particular residence is mentioned in the agreement with the project proponent.
Any comment:	N/A

Data / Parameter:	**Volume of hot water consumed/utilized (for all metering system)**
Data unit:	m3
Description:	The above parameter refers to the volume of the hot water consumed/utilized delivered by the project SWH system(s) to the end uses
Source of data to be used:	Sample metering system and data logged and maintained by CME
Value of data applied for the purpose of calculating expected emission reductions in section B.5	-
Description of	The amount of water output from the SWH system will be estimated from the

measurement methods and procedures to be applied:	cumulative flow reading recorded by the temperature induced flow meter at an interval of 1 min and cumulated on a monthly basis. The cumulative flow will be used to estimate the heat gain on a monthly basis.
QA/QC procedures to be applied:	Quality control and quality assurance procedures are planned for monitoring of the project related data as the data will be used to calculate baseline emission. The uncertainty level of data archived is low as the measuring instruments will be calibrated in every three years.
Any comment:	The data measured will be archived both in paper and electronic spread sheet whereby the paper documentation will be kept with the service provider for the period of one year and the electronic data will be archived for a period of two years after the end of the crediting period.

Data / Parameter:	**Temperature of hot water (for all metering system)**
Data unit:	^{0}C
Description:	The above parameter refers to the temperature of the hot water flowing out of the system.
Source of data to be used:	Sample metering system and data logged and Maintained by CME
Value of data applied for the purpose of calculating expected emission reductions in section B.5	-
Description of measurement methods and procedures to be applied:	Measured by using thermocouple provided in the hot water output side of the system at an interval of 1 min. The reading will be recorded on daily basis (average of all temperature recorded across 24 hrs). The Daily temperature reading will be averaged on a monthly basis and used for calculation of heat gain.
QA/QC procedures to be applied:	Quality control and quality assurance procedures are planned for monitoring of the project related data as the data will be used as a supporting documentation to calculate baseline emission. The uncertainty level of data archived is low as the measuring instruments will be calibrated on a three year basis.
Any comment:	The data measured will be archived both in paper and electronic spread sheet whereby the paper documentation will be kept with the service provider for the period of one year and the electronic data will be archived for a period of two years after the end of the crediting period.

Data / Parameter:	**Temperature of cold water (for all metering system)**
Data unit:	^{0}C
Description:	The above parameter refers to the ambient temperature of the cold water entering into the thermal storage system.
Source of data to be used:	Sample metering system and data logged and Maintained by CME
Value of data applied for the purpose of calculating expected emission reductions in section B.5	-

Description of measurement methods and procedures to be applied:	Measured by using thermocouple provided in the cold water inlet to the thermal storage device of the SWH system. The reading will be recorded on daily basis (average of all temperature recorded across 24 hrs). The Daily temperature reading will be averaged on a monthly basis and used for calculation of heat gain.
QA/QC procedures to be applied:	Quality control and quality assurance procedures are planned for monitoring of the project related data as the data will be used as a supporting documentation to calculate baseline emission. The uncertainty level of data archived is low as the measuring instruments will be calibrated on three years basis.
Any comment:	The data measured will be archived both in paper and electronic spreadsheet whereby the paper documentation will be kept with the service provider for the period of one year and the electronic data will be archived for a period of two years after the end of the crediting period.

Data / Parameter:	**EC_{PE} (for all metered forced draft system)**
Data unit:	MWh
Description:	The above parameter refers to the electricity consumption by the pump and other auxiliary.
Source of data to be used:	Sample metering system and data logged and Maintained by CME
Value of data applied for the purpose of calculating expected emission reductions in section B.5	-
Description of measurement methods and procedures to be applied:	Will be measured by electromagnetic/ electronic type energy meter and recorded on a monthly basis. The monthly energy consumption will be used for calculation of project emission.
QA/QC procedures to be applied:	Quality control and quality assurance procedures are planned for monitoring of the project related data as the data will be used as a supporting documentation to calculate project emission. The uncertainty level of data archived is low as the energy meter will be calibrated on three year basis.
Any comment:	The data measured will be archived both in paper and electronic spread sheet whereby the paper documentation will be kept with the service provider for the period of one year and the electronic data will be archived for a period of two years after the end of the crediting period.

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

The monitoring of the project is framed in accordance to approved baseline methodology AMS-I.J. "Solar water heating systems (SWH)", version 01 is applied for a CPA. Issues pertaining to monitoring are addressed in section A.4.4.2 above. In furtherance the following issues are addressed over here.

The monitoring of the CPA is proposed in accordance to AMS-I.J, paragraph 13, 14, 15, 16, 18 and 19.

In accordance to paragraph 13 of the methodology and also as described in the Section A.4.4.2 of the PoA DD the CME will undertake the acceptance test within three months of the installation of the system. As a part of acceptance test
The CME will keep record of the beneficiary level information as against each of the unique identification number in accordance to the database checklist in section A.4.4.1
Based on the acceptance test the monitoring team will provide the report to the database management team who will include the particulars of the information collected and verified by the inspection team. The data archiving and record keeping procedure will prevent will prevent double counting across the CPA and each of the SWH system can be uniquely identified and spatially placed based on the unique identification number.

Following are the data parameters to be monitored / inspected by sampling
The systems under the CPA would be so selected that a single monitoring approach is followed for a CPA

Type of Systems under a CPA	Monitoring Approach	Sampling framework
CPA with very small system at residential sector (capacity of all the system considered is less than $8m^2$)	Stipulated energy saving method	Sample system to be surveyed to determine the proportion of the system that are in operation in accordance to manufacturer specification.
CPA with small system at residential system (more than $8m^2$ and less than $100m^2$ across residential units)	System metering at sample site	Monitoring system will be placed across sample system

1. Sampling design for very small residential SWH system (≤ 8 m^2)

Objective: In accordance to paragraph 14 of the methodology the residential system could claim for emission reduction only if it can be demonstrated that the system are in operation in compliance with the manufacture required maintenance procedure. As a part of the monitoring procedure the methodology provisions for undertaking inspection on a statistically valid sample to determine the percentage of systems operating in compliance with manufacturer-required maintenance procedures. The objective of the survey is to estimate the percentage area of SWH system that are in operation and in compliance with the manufacturer –required maintenance procedure.

Reliability Requirement: As per Paragraph 15 of the approved methodology AMS-I.J.; in case the survey is carried out on annual basis; 90% confidence interval and 10% margin of error needs to be considered.

Target Population: The maximum number of system that can be conceived under a small scale methodology is limited to 64,000 m^2. Considering the minimum individual collector size to be conceived under PoA being $1.5m^2$ for ETC based system, thus for any CPA using very small systems the maximum systems will be 42,666 considering 64000 m^2 for small scale threshold. The entire geographic area of the CPA will be considered.

Survey Method: Simple Random Sampling

Simple random sampling is selected as the technology and user type (residential) is same. However if the CPA includes SWH system at multiple geographical locations (state boundary) total number of systems to be surveyed in each location will be selected from each geographical location will be proportionate to the total collector area in each geographical location i.e. the state boundary. As the state wise demographics is very homogenous (usage type and weather conditions are similar) district wise clustering wont be done as standard errors will be high. But extra samples will be included where the homogeneity is not envisaged in a particular district(s) after the implementation of the CPA.

Sample Size:
The sample size is determined in accordance to the modalities stipulated under Paragraph 14 and 15 of the methodology and in accordance to "Guidelines for Sampling and Surveys for CDM Project Activities and Programme of Activities" Annex 5 EB 69 and is as follows:

The sample size is calculated using exact equation for random sampling as per paragraph 50 of Annex 5 EB 69

$$n \geq 1.645^2 N*p*(1-p) / ((N-1) * 0.1^2 * p^2 + 1.645^2 p*(1-p))$$

Where,

n = Sample size

N = Total number of system (42,666 maximum)[36]

p = expected proportion (and on basis of assumption that, 90% of SWH system will be operational in compliance with the manufacturer required maintenance procedure i.e. Proportion of the SWH system in operation during a particular year is 0.9. (This based on the Manufacture letter for the excepted proportion of collectors operating till the life time and it is only to determine the sample size and higher reliability.)

1.645 = Represents 90% confidence required

0.1 = Represent 10% relative precision

The number of sample system will be estimated based on 42666 maximum number of installation conceived under each CPA which uses very small system as per the equation will be 31 (rounded).
For covering 100 percent of the sample and expecting a response rate of 80%; the sample size will be scale up accordingly. Thus, the sample size will be estimated as by dividing the number of sample system by 80% i.e. i.e 31/80% = 39. However, to cover the wide range of population and have a conservative sample the PP will select 2.5 times and rounding up the number of sample to be surveyed is 100. So the number of systems to be sampled in each CPA is determined to be 100 irrespective of installation on a conservative approach conceiving 42,666 installations across each CPA.

Data to be collected

Field Measurement – Frequency: The sampling will be carried out on an annual basis. The inspection will be carried out one year after the date of acceptance test or within a year from the date of registration whichever is later. There after once in every year the survey will be conducted.
An acceptance report in specified format duly signed by the beneficiary and the concerned manufacturer/.agency involved in annual maintenance will be used.
The following will be collected as the part of survey

[36]Considering the small scale threshold of 64,000 m^2 and minimum solar water heater size (ETC) of 1.5m^2 total number of systems in any CPA will be less than 42,666.

1. Confirmation from the beneficiary (with signatures in the survey form) that system is in operation till date.
2. Details of the schedule maintenance.
3. Number of family numbers.
4. Name of the Beneficiary. (Unique ID will be matching)
5. Location.
6. Type and capacity of the collector.

QA/QC Procedure: Each system will be assigned with unique identification details. The systems to be sampled will be randomly selected using software or random number tables and screen shots of the same will be kept in the data base. The CME will get the services of third party agency for taking the survey before the preparation of the monitoring report.

The samples once surveyed in a year will not be considered for subsequent year. The survey details will be cross checked with the maintenance records. However, the emission reductions will not be considered for the non-functional days due to maintenance which will be taken from the maintenance records.

Analysis: Based on the response the percentage of SWH system that are in operation and in compliance with the manufacturer –required maintenance procedure will be calculated. The percentage will be used to determine the total number of SWH system in operation.
The percentage of SWH system in operation calculated across each state will be multiplied with total collector area across each state to determine the total collector area to be considered for emission reduction estimation across each state. The following calculation will be used to estimate the total collector area under operation.

State	Total collector area	% area of FPC	Proportionate number of sample to be inspected (irrespective of size) (Rounded up Integer)	Number of FPC Samples (Rounded up Integer)	Number of ETC samples (Rounded up Integer)	Percentage of FPC Collector area in Operation(based on the survey)	Percentage of ETC Collector area in Operation(based on the survey)	Total Collector area to be considered for emission reduction estimation (Rounded down in m^2)
1	X1	Y1	A1=100*(X1/(X1 +x2+...+Xn))	B1=A1*Y 1	C1= A1-B1	D1	E1	F1=D1*Y1 *X1+ E1*(1-Y1)*X1
2	X2	Y2	A2	B2	C2	D2	E2	F2
n	Xn	Yn	An	Bn	Cn	Dn	En	Fn

The total collector area in any CPA for emission reduction calculation = F1+F2+....+Fn.

2. Sampling design for small residential SWH system

Objective: In accordance to paragraph 10.b.v of the methodology - small SWH system (collector area above $8m^2$ and below $100m^2$) established across residential unit and using system metering method for estimation of emission reduction can opt for determining energy saving/ heat gain from a statistically

valid sample of residences where the systems are installed. The objective is to determine the number of residential unit where monitoring system needs to be installed. As per Paragraph 15 of the approved methodology AMS-I.J.; in case the survey is carried out on annual basis; 90% confidence interval and 10% margin of error needs to be considered.

Target population: The cumulative collectors are that can be conceived under a small scale methodology is limited to 64,000 m^2. Since the minimum capacity of the SWH system in residential establishment to be conceived for system metering method is $8m^2$ therefore the maximum number residential system will be limited to 8000. Conceiving 90% of the system will operate at desired efficiency level across the life time the number of system to be monitored is 31. Considering the 10% margin of error the number of system to installed will be 35 (rounded up)

Sampling Approach – Simple Random Sampling

Simple random sampling is selected as the technology and user type (residential) is same. However if the CPA includes SWH system at multiple geographical location total number of systems to be monitored will be distributed in proportionate to the total collector area in each geographical location i.e. the state boundary. As the state wise demographics are very homogenous (usage type and weather conditions are similar) district wise clustering is not done as standard errors will be high. However after the implementation of the CPA if any district demographics are not homogenous then the proportionate number of monitoring systems will be added extra to the sample size.

Sample Size:

The sample size is determined in accordance to the modalities stipulated under Paragraph 14 and 15 of the methodology and in accordance to "Guidelines For Sampling and Surveys for CDM Project Activities and Programme of Activities" Annex 5 EB 69 and is as follows:
The sample size is calculated using exact equation for random sampling as per paragraph 50 of Annex 5 EB 69

$$n \geq 1.645^2 N*p*(1-p) / ((N-1) * 0.1^2*p^2 + 1.645^2 p*(1-p))$$

Where,

n	=	Sample size
N	=	8000
p	=	Expected proportion (and on basis of assumption that, 90% of SWH will be operational and is operating in compliance with the manufacturer required maintenance procedure i.e. Proportion of the SWH in operation during a particular year is 0.9. This assumption is only to determine the number of monitoring system to be installed)
1.645	=	Represents 90% confidence required
0.1	=	Represent 10% relative precision

The number of sample system will be estimated based on 8000 maximum number of installation conceived under each CPA which uses small system as per the equation above will be 35 (rounded).

Data to be collected

Procedure for Selection of number of Beneficiaries for Metering will be done as per the table:

State	Collector Area	FPC- Collector Area in % of total		ETC- Collector Area in % of		No of samples (Total Collector Area in any CPA as A)			
						FPC (rounded integers)		ETC (rounded integers)	
		Forced	Natural	Forced	Natural	Forced	Natural	Forced	Natural
1	A1	B1	C1	D1	E1	35*(A1*B1)/ A	35*(A1*C1)/ A	35*(A1*D1)/ A	35*(A1*E1)/ A
2	A2	B2	C2	D2	E2	35*(A2*B2)/ A	35*(A2*C2)/ A	35*(A2*D2)/ A	35*(A2*E2)/ A
n	An	Bn	Cn	Dn	En	35*(An*Bn)/ A	35*(An*Cn)/ A	35*(An*Dn)/ A	35*(An*En)/ A

The monitoring system is installed to estimate the heat gain and will monitor the following data daily and will be recorded monthly.

Parameter	**Meter**	**Recording frequency**	**Data collection frequency**
Inlet water temperature (cold water)	Temperature sensor	Impulse automatically imputed at span of 1 min and recorded on daily basis	The average of daily temperature data will be recorded on a monthly basis
Outlet water temperature (hot water)	Temperature sensor	Impulse automatically imputed at span of 1 min and recorded on daily basis	The average of daily temperature data will be recorded on a monthly basis
Flow	Flow meter	The flow meter will record the volume of water flow as and when it is used.	The cumulative flow will be computed on monthly basis
Electricity used	Energy meter	Recorded on monthly basis	Recorded on monthly basis

QA/QC Procedure: All the meters installed under the CPA (temperature, flow and energy) will be calibrated at a specified interval. The List of beneficiaries will be provided during the first monitoring report.
The emission reductions will not be accounted for non-functional days of any system due to maintenance or repair. This data will be obtained from CME database.

Analysis:

Procedure for Estimating the net heat gain per system per annum

1. The net heat gain will be determined from across each of the monitored system based on the total amount of hot water used and temperature rise monitored separately across the sample system on monthly basis. The sum of all the months will give the heat given for the annum.
2. The net heat gain calculated across all the sample system in a particular state boundary will be averaged in kCal/m^2/annum and will be multiplied with the total collector area in the state per annum. The total amount of heat gain will be used to estimate the emission reduction across a particular state.
3. The total amount of emission reduction estimated across the states covered under the CPA will be thereafter added up to obtain the net emission reduction (The step is not applicable for CPA covering installation across a single state).

The following procedure is used to calculate the average heat gain per m^2 of the collector per annum for the CPA.

Let EG_1 EG_2 EG_3…… EG_N be the heat gain per m^2 of the collector per annum for each of the metering systems, where N is the sample size (irrespective of the size of the collector for state / CPA).

Then the average heat gain per m^2 of the collector per annum (state/CPA) is calculated as follows

$$EG = \frac{EG_1 + EG_2 + EG_3 + \ldots\ldots + EG_N}{N}$$

Implementing

The sampling will be carried out by a third party agency with requisite expertise of verification. The Team will be provided with the requisite database by the CME.

Commercial System
In accordance to paragraph 16 of the approved methodology AMS.I.J version 1for commercial system following are the issues to be assessed

1. The System are monitored in accordance to monitoring procedure stipulated under section A.4.4.2 of the PoA DD
2. The authorisation from the end user that the system were in operation across the year and scheduled maintenance has been carried out in accordance to the specified maintenance requirement
3. Maintenance record are maintained by the end user and is duly signed by the maintenance team of the manufacturer cross verified by the CME team

System metering
For commercial system where system metering is used the following procedure will be ensured

Metering Parameter

Parameter	Meter	Recording	Data collection	Calibration

		frequency	**frequency**	**frequency**
Inlet water temperature (cold water)	Temperature sensor	Impulse automatically imputed at span of 1 min and recorded on daily basis	The average of daily temperature data will be recorded on a monthly basis	Once in every three years
Outlet water temperature (hot water)	Temperature sensor	Impulse automatically imputed at span of 1 min and recorded on daily basis	The average of daily temperature data will be recorded on a monthly basis	Once in every three years
Flow	Flow meter	The flow meter will record the volume of water flow as and when it is used.	The cumulative flow will be computed on monthly basis	Once in every three years
Electricity used	Energy meter	Recorded on monthly basis	Recorded on monthly basis	Once in every three years

System inspection for CPA monitored as per system metering approach and includes residential system with collector area between 8m^2 to 100m^2.

For solar water heating system with system capacity between 8m^2 to 100 m^2 and system metering method being applied on a sample basis as a part of monitoring approach an annual inspection is to be carried out for each beneficiary to ascertain the number of days of operation of solar water heater system in a year. Such non functional days should be due to operational fault and not because of weather condition will be excluded from the emission reduction calculations for those non functional collectors.

Ex-post estimation of Emission reduction

For the purpose of estimating the ex-post emission reduction following are the data parameters that will be ascertained

1. Acceptance test is being carried out
2. Maintenance record are collected and archived
3. Real time measurement data are available for system conceived under system metering method
4. The monitoring equipment are calibrated at regular specified frequency
5. Sampling is carried out for residential system to confirms the operation of the SWH system at the desired precision level

The emission reduction will be calculated based on the formula specified above.

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

The baseline study and monitoring methodology were completed on 27/10/2011 by

Agency	
MNRE	Dr. A K Singhal

UNDP	Dr. Pankaj Kumar

Supported by M/s G K Energy Marketers Pvt. Ltd and CTRAN Consulting

Annex 1

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

Organization:	**M/s G K Energy Marketers Pvt. Ltd**
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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

There has been no public funding against the project activity. Moreover there has been no Official development assistance used for the project activity.

Annex 3

BASELINE INFORMATION

Please see section E.1 to E.4.

Emission Factor of displaced electricity:

Emission factor shall be calculated, in accordance with the provisions in AMS-I.D "Grid connected renewable electricity generation" (tCO_2/MWh) and "Tool to calculate the emission factor for an electricity system".

Grid emission factor is estimated in accordance to the "Tool to calculate the emission factor for an electricity system" through the following steps:

Step1: Identification of the relevant electric power system.
Step2: Choose whether to include off grid power plant in the project electricity system (Optional)
Step3: Select a method to determine operating margin (OM).
Step4: Calculating the operating margin emission factor according to the selected method.
Step5: Calculate the build margin (BM) emission factor.
Step6: Calculating the combined margin (CM) emissions factor.

Step1: Identification of the relevant electric power system.

The Indian electricity system was previously divided into five regional grids, viz. Northern, Eastern, Western, Southern, and North-Eastern. Each grid covers several states. As the regional grids are interconnected, there is inter-state and inter-regional exchange. Since August 2006, however, all regional grids except the Southern Grid have been integrated and are operating in synchronous mode, i.e. at same frequency. Consequently, the Northern, Eastern, Western and North-Eastern grids will be treated as a single grid and is being named as NEWNE grid. The Southern grid has also been planned to be synchronously operated with rest of all Indian Grid by early 12th Plan (2012-2017). Therefore the Indian Power Sector is broadly divided into two Grids the NEWNE grid and the southern grid.

NEWNE Grid				Southern Grid
Northern	**Western**	**Eastern**	**North-Eastern**	**Southern**
Chandigarh	Chhattisgarh	Bihar	Arunachal Pradesh	Andhra Pradesh
Delhi	Gujarat	Jharkhand	Assam	Karnataka
Haryana	Daman & Diu	Orissa	Manipur	Kerala
Himachal Pradesh	Dadar & Nagar Haveli	West Bengal	Meghalaya	Tamil Nadu
Jammu & Kashmir	Madhya Pradesh	Sikkim	Mizoram	Pondicherry
Punjab	Maharashtra	Andaman-Nicobar	Nagaland	Lakshadweep
Rajasthan	Goa		Tripura	
Uttar Pradesh				
Uttaranchal				

The relevant grid will be chosen in the SSC-CPA level based on the state boundary in which the SWH system is installed.

Step2: Choose whether to include off grid power plant in the project electricity system (Optional)

The total installed capacity of grid connected power generating unit[37] till 30.06.12 is 1,41,216 MW , whereas the total installed capacity of off grid renewable power plant is around 736.678[38] MW eq. which is less than 10% of grid based power plant hence Option I has been chosen for calculation of Emission factor i.e. "Only grid power plants are included in the calculation". Based on the aforementioned fact grid emission factor has been estimated taking into account grid based power plant.

Step3: Select a method to determine operating margin (OM).
The operating margin refers to a cohort of power plants that reflect the existing power plants whose electricity generation would be affected by the proposed CDM project activity.
In accordance to the "Tool to calculate the emission factor for an electricity system" the Operating margin for the selected project electricity system can be estimated through adaptation of one of the following methods.
(a) Simple OM, or
(b) Simple adjusted OM, or
(c) Dispatch data analysis OM, or
(d) Average OM.
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.

Share of Must-Run (Hydro/Nuclear) (% of Net Generation)					
	2006-07	2007-08	2008-09	2009-10	2010-11
NEWNE	18.5%	19.0%	17.4%	15.9%	17.6%
South	28.3%	27.1%	22.8%	20.6%	21.0%
India	20.9%	21.0%	18.7%	17.1%	18.4%

From the analysis of the power generation scenario it is evident that the low-cost/must-run resources constitute less than 50% of the net generation for both therefore the simple operating margin has been chosen for estimating the operating margin emission factor.

For the simple OM, the simple adjusted OM and the average OM, the emissions factor can be calculated using either of the two following data vintages:

• Ex ante option:
If the ex ante option is chosen, the emission factor is determined once at the validation stage, thus no monitoring and recalculation of the emissions factor during the crediting period is required. For grid power plants, use a 3-year generation-weighted average, based on the most recent data available at the time of submission of the CDM-PDD to the DOE for validation. For off-grid power plants, use a single calendar year within the 5 most recent calendar years prior to the time of submission of the CDM-PDD for validation.

• Ex post option:

[37] http://cea.nic.in/reports/monthly/executive_rep/jun12/8.pdf

[38] http://mnre.gov.in/mission-and-vision-2/achievements/

If the ex post option is chosen, the emission factor is determined for the year in which the project activity displaces grid electricity, requiring the emissions factor to be updated annually during monitoring. If the data required to calculate the emission factor for year y is usually only available later than six months after the end of year y, alternatively the emission factor of the previous year y-1 may be used. If the data is usually only available 18 months after the end of year y, the emission factor of the year preceding the previous year y-2 may be used. The same data vintage (y, y-1 or y-2) should be used throughout all crediting periods.

The emission factor will be calculated using Ex ante options. Under ex ante option the emission factor is determined will be fixed for the crediting period and does not require further monitoring and recalculation during the crediting period.

Step4: Calculating the operating margin emission factor according to the selected method
The simple operating margin emission factor is calculated as the generation weighted average CO_2 emission per unit net generation (tCO_{2e}/MWh) of all generating power plants serving the system, not including low cost/ must run power plants/units. The estimation is done based on data on fuel consumption and net electricity generation of each power plant/unit.

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 CO2 emission factor of each power unit;
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.

For the Estimation of Operating Margin Option "B" has been used
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:

$EF_{grid,OMsimple,y} = \sum(FC_{,i,y} * NCV_{i,y} * EFCO_{2i,y})/ EG_y$ ---------- Equation 6
(Tool to calculate the emission factor for an electricity system, version 2.2.1)
Total Amount of emission due to fuel consumption in fossil fuel based power plant has been estimated and published by Central electricity authority.

Absolute Emissions OM (tCO2)					
	2006-07	2007-08	2008-09	2009-10	2010-11
NEWNE	38,56,92,794	40,68,61,785	43,05,02,442	45,30,67,520	46,84,38,871
South	10,90,20,456	11,35,86,133	11,78,80,640	12,67,86,215	12,90,93,636
India	49,47,13,250	52,04,47,919	54,83,83,082	57,98,53,735	59,75,32,507

Absolute Emissions BM (tCO2)					
	2006-07	2007-08	2008-09	2009-10	2010-11
NEWNE	5,90,42,467	6,01,93,616	6,92,97,387	8,85,93,337	10,11,46,601
South	2,13,48,182	2,25,50,310	2,58,51,338	2,75,58,555	2,58,82,886

India	8,03,90,649	8,27,43,926	9,51,48,726	11,61,51,892	12,70,29,488

Gross Generation Total (GWh)					
	2006-07	2007-08	2008-09	2009-10	2010-11
NEWNE	4,99,380	5,31,539	5,48,956	5,86,311	6,22,447
South	1,61,897	1,67,379	1,67,587	1,80,638	1,85,257
India	6,61,277	6,98,918	7,16,543	7,66,950	8,07,704

Net Generation Total (GWh)					
	2006-07	2007-08	2008-09	2009-10	2010-11
NEWNE	4,65,361	4,96,119	5,10,693	5,44,915	5,79,181
South	1,52,206	1,57,247	1,57,336	1,69,765	1,73,925
India	6,17,567	6,53,366	6,68,029	7,14,680	7,53,106

Share of Must-Run (Hydro/Nuclear) (% of Net Generation)					
	2006-07	2007-08	2008-09	2009-10	2010-11
NEWNE	18.5%	19.0%	17.4%	15.9%	17.6%
South	28.3%	27.1%	22.8%	20.6%	21.0%
India	20.9%	21.0%	18.7%	17.1%	18.4%

Net Generation in Operating Margin (GWh)					
	2006-07	2007-08	2008-09	2009-10	2010-11
NEWNE	3,79,471	4,01,642	4,21,803	4,58,043	4,76,987
South	1,09,116	1,14,634	1,21,471	1,34,717	1,37,387
India	4,88,587	5,16,275	5,43,274	5,92,760	6,14,374

For NEWNE Grid
$EF_{grid,OMsimple,y}$ = 0.9842tCO_2/MWh

For South Grid
$EF_{grid,OMsimple,y}$ = 0.9516 tCO_2/MWh

Step5: Calculate the build margin (BM) emission factor.
The Build Margin is calculated as per Option 1 of Step 5 of the Tool to calculate the emission factor for an electricity system.
The build margin reflects the average CO_2 intensity of newly built power stations that will be (partially) replaced by a CDM project. In accordance with the Grid Tool, the build margin is calculated in this database as the average emissions intensity of the 20% most recent capacity additions in the grid based on net generation. Depending on the region, the build margin covers units commissioned in the last five to ten years.

20% of Net Generation (GWh)					
	2006-07	2007-08	2008-09	2009-10	2010-11
NEWNE	93,072	99,224	1,02,139	1,08,983	1,15,836
South	30,441	31,449	31,467	33,953	34,785
India	1,23,513	1,30,673	1,33,606	1,42,936	1,50,621

Net Generation in Build Margin (GWh)					
	2006-07	2007-08	2008-09	2009-10	2010-11
NEWNE	93,524	1,00,707	1,02,589	1,09,064	1,17,779
South	30,442	31,613	31,606	36,100	35,268
India	1,23,965	1,32,320	1,34,195	1,45,164	1,53,047

For NEWNE Grid
$EF_{grid,BM,y}$ 0.85878tCO_2/MWh

For Southern Grid
$EF_{grid,BM,y}$ = 0.7338tCO_2/MWh

Step 6 : Calculate the combined margin emissions factor
The combined margin emission factor will be calculated using Weighted average CM approach.
The combined margin emissions factor is calculated as follows:
$EF_{grid,CM,y} = EF_{grid,OM,y} \times w_{OM} + EF_{grid,BM,y} \times w_{BM}$ -------Equation 13

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 (%)

Where w_{OM} = 0.5 and w_{BM} = 0.5 for the first crediting period

Combined Margin Emission Factor For NEWNE Grid
The following default values is used for wOM and wBM , wOM = 0.5 and wBM = 0.5.
$EF_{grid,CM,y} = EF_{grid,OM,y} \times W_{OM} + EF_{grid,BM,y} \times W_{BM}$
$= 0.9842 \times 0.5 + 0.8587 \times 0.5$
$= 0.9215$ tCO_2/MWh

Combined Margin Emission Factor For Southern Grid
The following default values is used for W_{OM} and W_{BM} , W_{OM} = 0.5 and W_{BM} = 0.5.
$EF_{grid,CM,y} = EF_{grid,OM,y} \times wOM + EF_{grid,BM,y} \times wBM$
$=0.9516 \times 0.5 + 0.7338 \times 0.5$
$= 0.8427$ tCO_2/MWh

Emission factor of the displaced fossil fuel:

Taken or calculated from recent IPCC default values.

Annex 4

MONITORING INFORMATION

Please see section E.7.

Appendix - (LIST OF ABBREVIATION)

BIS – Bureau of Indian Standard
CME – Co-ordinating and Managing Entity
DOE- Designated Operational entity
DNA- Designated National Authority
EB – Executive Board
ESCO – Energy Service Company
ETC- Evacuated Tube Collector
FPC- Flat Plate Collector based system
GEF – Global Environment Facility
ID – Identity
ISI- Indian Standards Institute
LPD- Litre per day
MNRE- Ministry of New and Renewable Energy
PSU – Public Sector Undertaking
RESCO –Renewable Energy Service Company
SWH – Solar Water Heater
UNDP- United Nation Development Programme

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