Programme of activities design document form
(Version 09.0)

Complete this form in accordance with the instructions attached at the end of this form.

BASIC INFORMATION	
Title of the PoA	**Solar Water Heater Program in India**
Version number of the PoA-DD	11
Completion date of the PoA-DD	12/02/2020
Coordinating/managing entity	Nuetech Solar Systems Pvt. Ltd
Host Parties	India
Applied methodologies and standardized baselines	AMS.I.C./Version 21 “Thermal energy production with or without electricity”
Sectoral scopes	Sectoral Scope 1: Energy industries (renewable - / non-renewable sources)

PART I. Programme of activities (PoA)

SECTION A. Description of PoA

A.1. Purpose and general description of PoA

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India has a population of approximately 1,364 million[1] inhabitants that is rapidly growing and becoming increasingly urban (34% live in urban areas[2]). Energy needs are growing and households consume around 22% of India's electricity, while residential power consumption is still growing sharply. The main energy services needs of households in India are for cooking, water heating and lighting, with 12% used for water heating, creating a peak in power demand in the mornings.[3] Solar water heaters provide access to renewable energy to meet at least part of this demand.

Despite the abundant availability of solar energy, an estimated 12% of the Indian population still uses electric geysers and another 6.8% electric coil or rod type heaters. Only 6% has adopted solar water heaters.[4]

On an average 0.91 kg of CO_2[5] is produced when one kWh of electricity is generated by grid-based power plants, which are primarily fossil fuel based. Heating water requires a significant amount of electric power[6,7].Apart from households, electricity is also the major energy source for heating water in hotels, hospitals, hostels and other commercial and institutional buildings.[8]

Hot water requirement for various applications in buildings are listed in table 1.

Table 1: Hot water application

Buildings		**Hot water application**
Residential		Bathing, shaving, cooking, cleaning and washing of clothes.
Commercial	Hotels	For maintenance of guest rooms, housekeeping, laundry services, and maintenance of kitchens.
	Hospital	Sanitation and various medical purposes
	Hostels	Bathing, shaving, kitchen and clothes washing
	Institutions and others	Hot water for lavatories, lunchroom etc

[1] Worldometers (http://www.worldometers.info/world-population/india-population/), data from 4 March 2019.

[2] World bank (2019), Urban population, India, available from: https://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS?locations=IN

[3] Prayas (Energy Group) (2016), Residential Electricity Consumption in India: What do we know?, available from: http://www.prayaspune.org/peg, (figures 10, 17, A4 and A5)

[4] Prayas (Energy Group) (2016), Residential Electricity Consumption in India: What do we know?, available from: http://www.prayaspune.org/peg, (figure A3)

[5] *CO2 Baseline Database for the Indian Power Sector User Guide Version 14.0* (2018). (Central Electricity Authority, India)

[6] World Bank (1999): *Household Energy Strategies for Urban India the Case of Hyderabad, available from: http://documents.worldbank.org/curated/en/213441468772786319/India-Household-energy-strategies-for-urban-India-the-case-of-Hyderabad*.

[7] UNEP Riso, Barriers to the Diffusion of Renewable Energy technologies – A case Study of the State of Maharashtra, India (Roskilde, 2001), page 21.

[8] Dr Sameer Maithel, Solar water heaters in India: market assessment studies and surveys for different sectors and demand segments (New Delhi, 2010).

Significant savings in electricity are possible by using solar energy to heat water and in energy expenses. Fuel use make up 10% of household expenditure.[9] When a solar water heater (SWH) replaces an EWH, it not only saves electricity but also reduces the peak load demand from the grid. The gross potential for solar water heating systems in India has been estimated at 140 million m^2 [10] of collector area.[11] A target of 15 million m^2 had been set for 2017 and 20 million m^2 by 2022,[12] but the collector area of solar heaters stood at 9 million m^2 by the year 2016[13]. In result, adoption remains below the earlier policy targets.[14] In practice, SWHs still face barriers for their widespread application in the residential sector and industry.[15]

Purpose of the programme of activities

Solar Water Heater Program in India (hereafter "the Programme" or PoA) is a small scale CDM Programme of Activity (PoA). The purpose of the Programme is to install a SWH in residential as well as commercial buildings throughout India. The program saves electricity generated from fossil fuels by using renewable energy to meet hot water requirement and will result in reduction of CO_2 emissions.

SWH is a device that uses thermal energy of the sun to produce hot water for various applications. SWH consists of a solar collector in which a surface area facing the sun collects solar energy, or solar energy is directly used, to heat water. An insulated tank stores the hot water until it is used and pipes finally transfer the hot water to its point of usage. The SWH also includes supporting structures and piping. In most systems, circulation of fluid from the tank through the collectors and back to the tank happens naturally due to thermo-siphon effect. For some, typically larger systems, a pump is used to circulate fluid. These systems have the potential of capturing solar energy, as per one estimate, of up to 1,000 kWh/m^2/year, depending on location[16].

Nuetech Solar Systems Pvt. Ltd (Nuetech) is the coordinating/managing entity (CME) for this PoA. Its responsibility is to communicate with the CDM Executive Board and coordinate the work relating to validation, verification, registration and issuance of carbon credits generated by the PoA. Nuetech will act as the CDM program activity (CPA) Implementer of the first CPA. The CPA Implementer will be referred to as the CPAI. Nuetech may be the CPAI of subsequent CPAs but other manufacturers and distributors of SWH will also be incorporated in the later stages of the Programme as implementers of additional CPAs.

The PoA is a voluntary activity proposed by Nuetech, the CME of the PoA. All project participants are voluntarily taking part in this programme.

Contribution to sustainable development:
a) Economic wellbeing

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[9] IFMR Research (2016), Atlas of household energy consumption and expenditure in India (figure 3).

[10] MNRE (no date) *Background paper on status of solar water heating in India* (MNRE UNDP/GEF Global Solar Water Heating Project).

[11] Throughout this document, any reference to area of the SWH refers to the aperture area, which is the area over which the solar radiation enters the collector, unless otherwise stated.

[12] IRENA (2017), Working Paper, Remap renewable energy prospects for India

[13] *UNIDO (2017) India's CST Sector - Vision 2022*

[14] Narasimhe Gowda (2014), Solar Water Heaters Usage in India –Current Scenario and Vision 2020-Review International Journal of Recent Development in Engineering and Technology Volume 2, Issue 2, February 2014

[15] P.Veeraboina (2012), Analysis of the opportunities and challenges of solar water heating system (SWHS) in India: Estimates from the energy audit surveys &review, Renewable and Sustainable Energy Reviews 16

[16] MNRE (2016) Report of the working group on new and renewable energy for XIth five-year plan (2007-12)

SWH utilize solar radiation as a source of energy which is a renewable source available free of cost. The activity results in savings in fuel cost by avoiding use of electricity. Reducing electricity use also reduces emission from power generation. India still has power shortages[17].
Reducing power demand will help avoid power shortages in the future. Reliable access to power is an important requirement for economic development.[18]

b) Environmental wellbeing
The PoA reduces electricity consumption and thereby reduces the amount of greenhouse gasses produced by fossil fuel combustion at the national electricity grid. Coal remains the dominant fuel in the Indian power mix[19]. By reducing power demand, the programme reduces the emission of greenhouse gasses but also of other pollutants such as CO, SO_x, NO_x.

c) Social wellbeing
The programme will contribute to social development by income and employment generation. The Programme will employ people for SWH manufacturing, distribution, installation and maintenance. In addition, the SWH provide access to a renewable source of energy, which reduces the exposure of their users to changes in power prices in India.

d) Technological wellbeing
The programme demonstrates a replicable renewable technology and enhances the commercialization of renewable energy technology on the level of households and SME. As such, the programme brings low carbon solutions within reach of the people of India.

Next to this, under the Gold Standard for Global Goals, the project is monitoring its impact beyond climate, along the following Sustainable Development Goals:

- SDG 3: Good Health And Well-Being
- SDG 4: Quality Education
- SDG 7: Affordable And Clean Energy
- SDG 8: Decent Work And Economic Growth
- SDG 9: Industry, Innovation And Infrastructure
- SDG 13: Climate Action
- SDG 17: Partnerships For The Goals

A.2. Physical/geographical boundary of PoA

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Geographical Boundary

The SSC-CPAs that will be included under the SSC-PoA will be within the defined geographical location of the SSC-PoA area and follow applicable national and / or sectoral policies and regulations. The geographical boundary of the SSC PoA is the Republic of India.

Latitude – North 6.75 degrees to North 37.10 degrees
Longitude – East 68.03 degrees to East 97.40 degrees.[20]

[17] Ministry of Power – Government of India (2019) Power Sector at a Glance ALL INDIA, available at: https://powermin.nic.in/en/content/power-sector-glance-all-india, shows a power deficit of 0.8.

[18] Arun P. Sanhvi, *Power shortages in developing countries: Impacts and policy implications*, Energy Policy 2003.

[19] Ministry of Power – Government of India (2019) Power Sector at a Glance ALL INDIA, available at: https://powermin.nic.in/en/content/power-sector-glance-all-india,

[20] Source: http://www.mapsofworld.com/lat_long/india-lat-long.html.

Figure 1: Geographical boundary for the PoA.

A.3. Technologies/measures

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The PoA consists of CDM Program Activities (CPAs), each with a maximum number of installations up to 64,000 m^2 collector area, therefore respecting the limits for small-scale CDM activities as defined by the "Analysis and explanation of the conversion factor for solar thermal collectors" from the Small Scale Working Group[21].

In a typical CPA, SWH systems will be installed in residential and commercial buildings throughout India (Appendix 4 contains a list of buildings included in the PoA). A SWH system utilizes solar energy for water heating. SWH will be composed of solar collectors and tanks for the heated water. Each CPA will include sales, distribution and installation of SWH systems. It will provide households and small, medium sized enterprises (SME) with in-house supply of hot water and will displace fossil fuels and carbon intensive electricity from the grid, thereby reducing greenhouse gas emissions. It will also promote commercialization of renewable energy technology.

The SWH technology has been developed specifically for the Indian market. No technology transfer to the host country is foreseen.

A.4. Coordinating/managing entity

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Nuetech Solar Systems Pvt. Ltd

A.5. Parties and project participants

Parties involved	Project participants	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
India (host Party)	Nuetech Solar Systems Pvt. Ltd	No

[21] Value obtained from Annex 3 of the Small Scale Working Group (SSC WG) Meeting 07.

Parties involved	Project participants	Indicate if the Party involved wishes to be considered as project participant (Yes/No)
Germany	Carbonbay GmbH & Co.KG.	No

A.6. Public funding of PoA

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No public funding or ODA have or will be diverted for the implementation of the PoA.

SECTION B. Management system

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The objective of the operation and management plan is to make systematic project execution and operation for the purpose of achieving real and measurable emission reductions and supporting the verification process. To achieve this, the following is put in place:

A record keeping system for each CPA under the PoA
The CME, Nuetech Solar Systems Pvt. Ltd. will maintain a digital database with all SWH systems in the PoA, with a clear division between the different CPAs. For each SHW installed also a paper copy of the sales record or invoice will be kept by the CPA implementer.

A system/procedure that avoids double counting
Double counting can occur if (components of) a proposed CPA are already part of a registered CDM project or part of a different PoA. Double counting is avoided by recording the serial number of each SWH system installed in each CPA[22] and by registering these numbers in the central SWH database together with the address and contact details of the user. The address of the location at which the system is installed is recorded in the order form and the invoice. The location's address or the serial number constitutes the unique identification of the system.

The database will be maintained by the CME. CMAIs may annually check the systems to ensure:
- That the recorded address at which the SWH collectors are installed is still correct,
- That the SWH collectors are still operational (as part of the monitoring procedure),
- That serial numbers are unique and the number in the database complies with the numbers on the system.

The CME will be responsible for archiving the serial numbers of each SWH system that is part of a CPA. The database will be maintained in association with the CPAIs and can be used by the CME and the DOE to identify and locate the each individual collector sold.

The central database will be maintained by the CME but data collection is the responsibility of the CPA Implementer (CPAI). The database will contain the following entries for all SWH users:

1. Name of CPA
2. Name of CPA Implementer
3. Name of dealer, if the SWH is supplied through a dealer,
4. Collector type (ETC/FPC) installed,
5. Serial number of the systems installed,
6. Collector area installed (m^2),
7. System capacity (litres),
8. Date of sale,
9. Date of commissioning/installation.
10. Customer name, address, mobile number,
11. State,
12. Capacity of pumps installed (if applicable).

[22] Unique serial numbers will be applied to the collector and/or the tank..

There are three situations in which the address or serial number may change.

- A collector or tank is replaced. In this case typically the owner of the system has contact with the manufacturer to support with the replacement. The manufacturer will record these cases and put the new serial number in the database.
- A collector is moved to a different location. Also here, typically, the dealer or supplier is informed. The new address will be recorded in the database.
- The system capacity is increased or decreased. With a decrease in system capacity the capacity in the database will be adjusted. With an increase a new entry will be added to the database for the new system.[23] In that case the same address can appear twice in the database but with two different serial numbers. Also in the monitoring plan these will be treated as two separate systems.

Changes in the database will be recorded while making a comment describing the change and listing the old data. This way, the database will also contain the history of each individual system in terms of changes, replacements, additions or relocations.

The database will potentially grow very large and some of the mutations listed above may remain out of sight of the CPAI and/or CME. If in the monitoring survey systems have changed or relocated, this will be mentioned in the monitoring report. This way the monitoring report also provides insight in the accuracy of the database management.

For existing systems the collector area may not be recorded in the database. For the vast majority of systems the ratio between the capacity of the system in litres and the collector surface is fixed (see section K). If a different type of system is used or if the ratio differs from the standard this will have to be recorded in the database to make sure the surface area is accurate.

For new systems, the database will record both the aggregated tank capacity in litres and the total surface of the system. The ratio between the two will be used to cross check the figures, automatically revealing any systems where the ratio has been changed, for example to get a higher output temperature.

Provisions to ensure that those operating the CPA are aware of and have agreed that their activity is being subscribed to the PoA

Each SWH owner participating in the PoA is required to sign a sales agreement in which it transfers the title to the emission reductions to the CPAI or CME. Each CPAI will have to sign an agreement with the CME before its participation in the PoA.

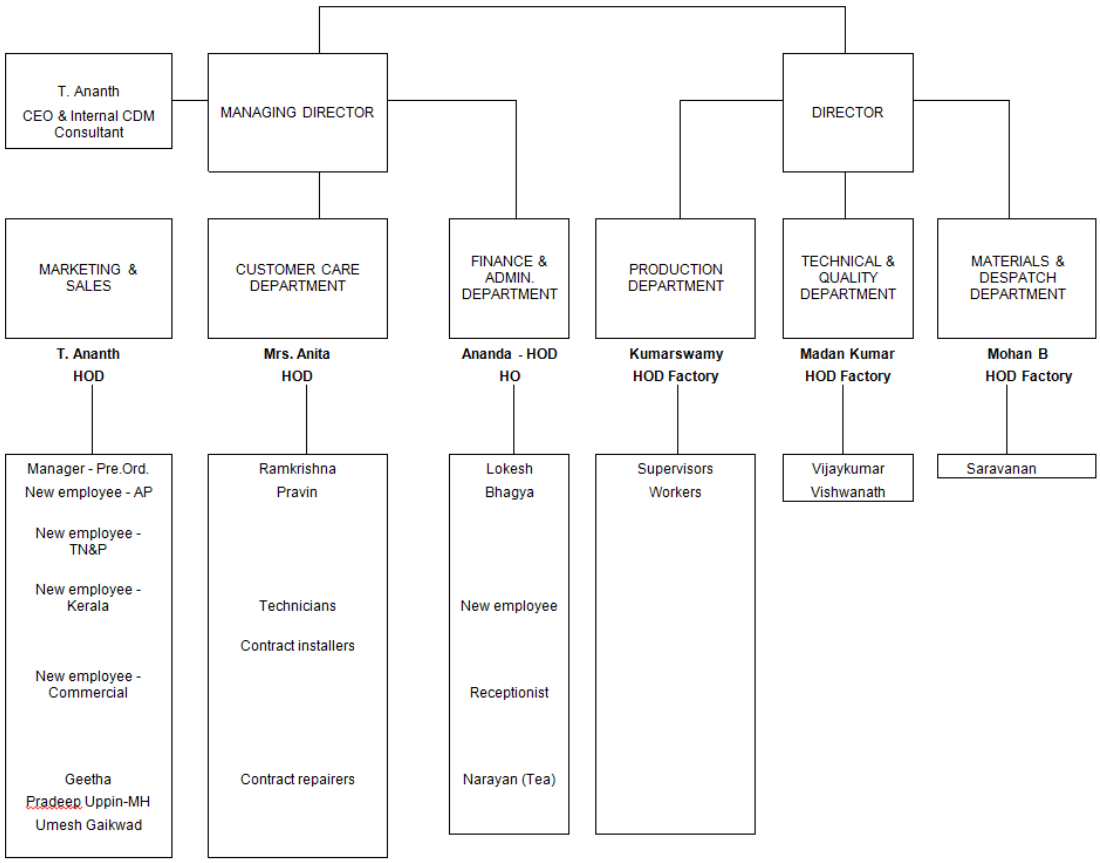
Roles and responsibilities

The organizational structure of the CME is presented in Figure 1. Names in the chart may change over time. The final responsibility for the implementation of the PoA-DD, CPA-DD and this manual lies with the Chief Executive Officer (CEO).

Curriculum vitae's and qualifications of key staff involved in the inclusion of CPAs can be made available to the DOE if requested.

Figure 1: CME organisational chart

[23] The capacity addition cannot be recorded under the existing entry in the database. That would create confusion with the start date and may lead to capacity additions to an already registered CPA, creating a risk that the size thresholds are exceeded. To avoid that, capacity additions will be listed as a new system in the database but with the same address as an existing system.



The roles and responsibilities of the CME to manage the PoA, and associated CPAs, in relation to the CDM project are defined below. This section defines responsibilities where they fall under the specific requirements of the CDM and is not intended to cover all responsibilities of each department and personnel.

Training and capacity development

CPA Implementers (CPAIs) are responsible for ensuring that the order form, installation records and invoice details are correct and complete. Training will be given to all CPAIs on the management system to be put in place as part of the PoA. This will include ensuring that all CDM responsibilities listed in section 2 have been allocated and that procedures are implemented.

- Data to be recorded in the database (as per A.4.4.1 of the PoA-DD) and how to develop and implemented procedures on gathering and archiving hardcopies of order forms, commissioning forms and ensure consistency between the hardcopies and the SWH database,
- How to ensure unique identification of each SWH through the serial numbers
- Where to send copies of the order form, installation records and invoice and any associated documentation,
- Procedure for dealing with a change in serial number, address or capacity of a SWH,
- Procedures to ensure that participating households or entities transfer their title to the CERs to Nuetech.
- Monitoring procedures, in accordance section A.4.4. of the PoA-DD.

Procedure for continues improvement

The management of Nuetech is committed to supporting improvements in the form of small-step on going activities integral to existing processes as well as breakthrough opportunities in order to gain maximum benefit for the organization and the interested parties. In order to identify areas for improvement, the following issues will be discussed during the Management Review meetings, which are typically held at least once a year:

- Effectiveness of programme at meeting CDM requirements

- Any inefficiencies in operation and management (e.g. in recording data or transferring data to database).
- Opportunities to employ better methods
- Control of planned and unplanned changes
- Measurement of planned benefits.

For supporting the improvement process, the information derived from the following will be used.

- Validation data
- Process yield data
- Test data
- Experience of people in the organization
- Financial data
- Product performance data
- Service delivery data

Once an area for improvement is identified, the Management Representative should check any changes with the PoA-DD and/or CPA-DD. Any deviation from the procedures and requirements as described in the PoA-DD or CPA-DD puts the carbon credits from the project at risk, and any improvements in the management system should therefore be checked against the PoA-DD and/or CPA-DD to ensure there is no conflict.

For a full description of the roles and responsibilities of individual staff involved, a review of their competences and training programmes, please refer to the CME manual

SECTION C. Demonstration of additionality of PoA

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

Voluntary Coordinated Action

The Indian government has set targets for the implementation of SWH systems and some states have implemented incentive schemes or laws to stimulate SWH implementation. However, on both state and national level the laws and initiatives that regulate SWH implementation are not enforced and the incentive schemes are available to only a few participants. The Letter of Approval from the Indian government, dated 10 October 2012 also confirms that participation in the project is voluntary.

The national government promotes solar power in the National Solar Mission[24] which provides incentives and sets the following targets for the total solar collector area installed in India:

- 7 million m^2 by the end of 2013,
- 15 million m^2 by the end of 2017,
- 20 million m^2 by the end of 2022.

These targets are not enforced and there is no penalty system in place to ensure that they are met.

The national government through MNRE used to provide incentives under the “Accelerated development and deployment of solar water heating systems in domestic, industrial and commercial sectors”. However, Subsidies for Solar Water Heaters in India were abolished in

[24] National Solar Plan- Final Draft29th April 2009,(2009) Govt. of India.

October 2014.[25] Table 2 provides an overview of the incentives when the investment decision was made and their development since. Note that throughout this PDD reference is made to MNRE, which is the ministry currently responsible for policies targeting SWHs. Throughout the lifetime of this PoA this responsibility could move to a different ministry of MNRE could be renamed. The name "MNRE" refers to the current ministry or whichever ministry will be responsible for SWHs in the future. The same conditions apply to other government authorities referred to in the context of this PoA.

Table 2: Incentives provided by the national government.

Time period	Incentives provided
2005-2007	The government provided soft loans for 85% of the investment costs of SWH systems with an interest rate of 2% for domestic, 3% for institutional and 5% for industrial and commercial users.
2008-2010	The government provided soft loans for 85% of the investment costs of SWH systems with an interest rate of 2% for domestic, 3% for institutional and 5% for industrial and commercial users. The latter group was also exempted from income tax on revenues that were invested in SWH systems. In addition, grants of up to INR 1 million were made available to State Electricity Boards and utilities, in return to providing a discount on the electricity tariffs for the users of SWH systems.
2010-2011	A 5% interest rate for all investors or a capital subsidy of around 30% of the investment costs. Until April 2011, the date in which this PoA-DD was updated, these incentives had not been implemented.
October 2014-Aug 2019	Solar Water Heater subsidies abolished, with no signs of them returning.

These financial incentives in practice did not, and still do not, work due to the following issues:

1. The soft loans listed in table 2 were made available only by a limited number of financial institutions. Appendix 4 contains an overview of participating institutions. Out of over 615 eligible financial institutions, only 19[26] are participating in the solar water heating program. Therefore there is limited access to SWH users to get benefits from this scheme.
2. In addition, an active bank account in the particular financial incentive is required for beneficiaries to participate. That is an additional barrier.
3. With INR 495 million, the funds available for the subsidy scheme were limited.
4. The procedures for participation in the subsidy scheme are lengthy and time consuming.
5. Manufacturers can also provide loans to their customers. However, only three of around 160 manufacturers experimented with such schemes but stopped providing these loans. For manufacturers with limited financial resources, it is difficult to provide the guarantees required from banks for loan security. Furthermore, it is unattractive for them to lock their capital, away in five-year loans, rather than to invest it in, for example, expanding production.
6. Finally, the discount on the electricity bill[27] when having a SWH installed is too small to attract consumers and the procedures to get access to the discount are too cumbersome.[28]

[25] Economic Times (2014), Indian Solar Water Heater manufacturers facing heat from Chinese imports, available from: https://economictimes.indiatimes.com/industry/cons-products/durables/indian-solar-water-heater-manufactures-facing-heat-from-chinese-imports/articleshow/45289749.cms.

[26] List of banks/ financing institutions participating in Solar water heating programme. The document is no longer available online. The hard copy of the document is provided to the DOE.

[27] HUBLI Electricity Supply Company Ltd, Electric Power Tariff– 2010. The document is no longer available online. The hard copy of the document is provided to the DOE..

[28] MNRE (2010), Final Report On Scheme and Framework for Promotion of Solar Water Heating Systems by Utilities and Regulators, page 101, available at: https://mnre.gov.in/sites/default/files/uploads/abps_SWHS_uandr_report.pdf

Due to these limitations and imperfections it is extremely complicated for SWH users and manufacturers to get benefits from the incentives provided by the central government.

Table 3: State-level government orders on SWH.[29]

#	State	Date of Issue
1	Andhra Pradesh	3rd August 2004
2	Maharashtra	31st December 2002
3	Tamil Nadu	September 2002
4	Haryana	29th July 2005
5	Uttar Pradesh	1st August 2004
6	Uttaranchal	August 2002
7	Chandigarh	12th December 2001
8	Himachal Pradesh	8th September 1995
9	Chhattisgarh	3rd December 2004 and 13th February 2005

There are also states that implemented regulations to stimulate SWH implementation. Table 3 shows that 19 out of 28 Indian states did not adopt regulations for the implementation of SWH. In the remaining 9 states there are governmental targets for SWH implementation. In general, since implementation of the relevant government orders has been either non-existent or is being implemented half-heartedly due to the inherent weaknesses or due to the political compulsions. Some of the municipalities/municipal corporations like Bengaluru and Mysore in Karnataka, Thane and Kalyan-Dombeveli in Maharastra have attempted to implement the provisions to some extent, with a lot to be desired. There have also been instances of public protests by consumers and electrical contractors against imposition of the mandatory rule.

Regardless of various government orders (some implemented already in 1995) and various incentives to SWH the penetration of technology is just ~2.5% or 3.5 million m^2 (table 3)[30]. The current implementation rate is insufficient to meet the targets,[31] which further substantiates the fact that targets are not enforced. Another major risk is that the public authorities will not be willing or able to adopt and/or enforce the recommended legal and regulatory changes at the adequate level to effectively advance the SWH market[32].Hence the mandatory policy/regulation is systematically not enforced and noncompliance is widespread in India.

Table 4: Status of SWH in India[33]

Technology	Installed systems in 2007	Potential	Achievement
Solar thermal systems/ devices	2.15 million m^2 collector area	140 million m^2 collector area	1.5%

As per the "Guidelines on the demonstration of additionality of small-scale project activities" project participants shall provide an explanation to show that the project activity would not have occurred anyway due to the existence of prohibitive barriers[34]: For the demonstration of

[29] Ministry of New and Renewable Energy, Govt of India, Akshay Urja, March-April 2008, page 38.

[30] Dr.B.S Reddy (2001) :*Barriers to the diffusion of renewable energy technology-A case study of Maharashtra*, IGIDR, Mumbai, India.

[31] UNDP, *Global solar water heating market transformation and strengthening initiative): Project Document, (New Delhi, 2008)*

[32] Dr Sameer Maithel, Solar water heaters in India: market assessment studies and surveys for different sectors and demand segments (New Delhi, 2010)

[33] Solar Energy info-kit 2008. ENVIS Centre on Renewable Energy and Environment, page 54

[34]EB 68, Annex 27, Guidelines on the demonstration of additionality of small-scale project activities (Version 09.0).

additionality the Annex 34 of EB 35 "Non-binding best practice examples to demonstrate additionality for SSC project activities" has been used, with a focus on the barriers 1) investment barrier, technical barrier, institutional barrier, barriers due to prevailing practice and other barriers.

Investment barrier

Table 7: Price of FPC and ETC systems (INR).

Component	FPC		ETC	
	100 litre/day	200 litre/day	100 litre/day	200 litre/day
Investment costs system	21,250	35,450	15,300	27,250
Piping	3,000	4,000	3,000	4,000
Installation (5 INR/litre)	500	500	1,000	1,000
Taxes (5%)	1,238	1,998	965	1,613
Total investment	25,988	41,948	20,265	33,863
Annual O&M (2.5% of investment)	650	1,049	507	847

Investment barrier

Climatic conditions in India are favourable for SWH technology but market growth remains low due to several barriers, including the investment barrier.[35] Both residential consumers as well as small and medium sized enterprises (e.g. hotels, rural businesses, textile industry),[36] consider the higher investment costs of a SWH as a significant barrier.[37,38,39,40] EWH systems on household level cost around 6,000 INR depending on location[41] while an SWH with similar capacity costs around INR 15,000 to INR 21,000, nearly two to three times as much (table 8). On the other hand, at the current low prices of electricity, solar water heaters cannot compete with electric water heaters in most parts of the country.[42]

This barrier is confirmed on CPA level through the criteria listed in section B.5.

Table 8: Cost comparison of SWH and EWH (systems only, no piping, installation and taxes)[43,44]

SWH capacity (in LPD)	Price of SWH in INR	EWH capacity in litres	Price of EWH in INR (Bajaj	Conclusion

[35] Global Solar Water Heating Market Transformation & Strengthening Initiative, (UNDP 2009), available at http://undp.org.in/sites/default/files/climate_pdf/10.pdf

[36] Dr Sameer Maithel, Solar water heaters in India: market assessment studies and surveys for different sectors and demand segments (New Delhi, 2010), amongst others, section 1.5; 3.8; 4.0; 7.2; 8.2; 9.3 and Annexure I.

[37] Ochani Kapil, Solar water heater costs in India, (2011), available at: http://ezinearticles.com/?Solar-Water-Heater-Costs-in-India&id=5648009.

[38] Professor Ashok Gadgil, *Domestic Solar Water Heater for Developing Countries*, Energy & Resources Group (2007)

[39] Karnataka renewable energy development ltd. Govt of Karnataka (http://kredl.kar.nic.in/SolarThermal.htm)

[40] IEA, Barriers to technology diffusion: the case of solar thermal technologies (2006).

[41] Government of India, *XITH Plan proposals for new and renewable energy* (2006) Ministry of new and renewable energy, .2006

[42] Sam Milton (2006): *Sustainable Development and Solar Water Heating Systems: An analysis of barriers to technology diffusion and recommendations for policy interventions*.

[43] Delhi Energy Efficiency & Renewable Energy Management Centre, Solar water heater: a device operating on renewable energy. The document is no longer available online. The hard copy of the document is provided to the DOE..

[44] A domestic solar water heater, with a capacity of 100 lpd (litres per day), is sufficient for a family of four or five members which would otherwise use a 2-kW electric geyser. (*Environmental Building Guidelines for Greater Hyderabad)* .Hyderabad Metropolitan Development Authority

			Electricals)[45]	
100	15,300-21,250	15	5,600-6,000	Capital cost of SWH is higher than EWH
200	27,250-35,540	25	7,050	

Barriers due to prevailing practice

Electric geysers are the norm in most cities for heating water for various purposes. Under a regime of cheap and subsidized grid power, affordable prices of electric geysers and the easy-off-the-shelf availability has ensured EWH to become the first choice in the entire urban and semi urban segment. The reluctance to change is well entrenched. Many construction companies of new houses also choose EWH because they are easy to install and relatively inexpensive to purchase[46]. In addition, when choosing for EWH, construction companies do not face This is a barrier due to prevailing practice. CDM revenues can support with the promotion of SWH, to improve awareness of the benefits compared to the conventional EWH.

The system's ability to heat and store hot water fluctuates depending on a wide range of conditions. This affects delivery of hot water, in particular during the rainy and winter season. People are used to ESW systems that can deliver hot water at any time of the day. That is different for SWH systems, creating a barrier for their adoption in households.

This barrier is confirmed on CPA level through the criteria listed in section K.

Institutional Barrier

SWH does not have the large dealer network that EWH has. Due to lack of awareness and the reputational issues that SWH still face due to poor quality systems used in the early days of SWH deployment,[47], the marketing of SWHs is crucial to improve the rate of penetration. On the other hand, the slow rate of penetration makes the business unattractive to potential dealers. The poor dealer network results in limited accessibility of potential users to the product, whereas EWH are available off – the shelf in all departmental and consumer durable outlets. Fast market growth is limited to only minor part of India and has limited access in the medium and smaller sized cities[48].

Manufacturers would need to develop a network of dealerships for easy availability and servicing of their products and services[49].

Other Barriers

Different studies confirm the barriers discussed above and even list other barriers. For example, a study from UNEP Risø "Barriers to the Diffusion of Renewable Energy Technologies"[50] mentions or

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[45] Bajaj Electricals Limited (http://www.bajajelectricals.com/pc-518-215-energy-efficient-vertical.aspx).

[46] Karnataka renewable energy development ltd. Govt of Karnataka , in the section "Economic Benefits of Solar water heaters", available athttp://kredl.kar.nic.in/SolarThermal.htm.

[47] IEA, Barriers to technology diffusion: the case of solar thermal technologies (2006)

[48] *Global solar water heating market transformation and strengthening initiative: India country program*, (2008) Govt of India and UNDP-GEF, see also Annex 1.

[49] *XITH Plan proposals for new and renewable energy* (2006) Ministry of new and renewable energy, Govt of India.

[50] UNEP Risø (2001), *Barriers to the Diffusion of Renewable Energy Technologies* by Dr.Sudhakar Reddy , Indira Gandhi Institute of Development Research,page 54, The document is no longer available online. The hard copy of the document is provided to the DOE..

Carbon finance and solar water heating technology (2004), Samuel Milton. The document is no longer available online. The hard copy of the document is provided to the DOE..

Solar Energy Info-kit from the ENVIS Centre on Renewable Energy and Environment (2008). The document is no longer available online. The hard copy of the document is provided to the DOE..

confirms the following barriers for SWH technology:

- Lack of sufficient information,
- Non-availability in the market,
- High initial cost,
- Low electricity bill and therefore no incentive,
- Uncertainty on the savings.

Realisation of the proposed program without the CDM is prevented by the barriers above and registering the proposed program as a CDM activity would help overcome these barriers. CDM revenues can be used to improve awareness that the higher investment costs are balanced by significant cost savings on power consumption, correct common prejudice against SWH compared to ESH as the default technology, reduce the investment barrier and/or improve the dealer network and expand their outreach and improve general awareness on SWH and its advantages.

Confirmation of additionality of the generic CPA for its inclusion into the PoA

The additionality of a proposed new SSC-CPA can be demonstrated in two different ways. The first is based on the lack of legal obligations to install SHW systems combined with a low market penetration. The second option would be to use micro-scale additionality. If a CPA meets all conditions under any of these two options it shall be considered additional under the PoA.

Option 1: No legal obligation combined with a barrier due to prevailing practice:

1. Prevailing practice would have led to implementation of a technology with higher emissions. The market penetration of SWH in households should not exceed 33% on state level, according to the latest publications from the Indian government, commissioned or funded by the Indian government. The 33% is based on the technology diffusion curves from Roger's where the innovators represent 2.5% of the market, the early adopters another 13.5% and the early majority 34%. The 33% includes half of the early majority since this category represents all sections of an economy whilst the innovators and early adopters are typically only the younger, higher educated, or better-informed part of the market.[51]
2. There should be no legal obligation to use SWH for water heating in the states where the SWH in the CPA are located. The legal obligation should be enforced with a clear penalty
3. regime.

Option 2: Micro-scale
The CPA is considered a micro-scale project activity since it meets the requirements in the "Guidelines for demonstrating additionality of microscale project activities" (EB 68, Annex 26). The Guideline applies to "renewable energy technology" and includes "All technologies/measures included in approved Type I Small Scale CDM methodologies". Through item 2 of the eligibility criteria in section K.., this criterion is met. According to version 04 of the guideline,[52] three criteria remain which are based on section 2.C of the guidance. For each CPA inclusion the latest version of this guideline will be applied.

1. Each of the independent subsystems in the project activity is smaller than or equal to 4500kW thermal installed capacity,
2. End users of the subsystems or measures are households, communities or SMEs.

[51] The market penetration should be assessed on state level, rather than on a national level, since legislation in India is also implemented on state level. The technology implementation curve can be found as figure 2 in the article "Adoption, Diffusion, Implementation, and Institutionalization of Educational Technology, from Daniel W. Surry, University of South Alabama at: http://www.usouthal.edu/coe/bset/surry/papers/adoption/chap.htm. See also "the diffusion process" at: http://www.soc.iastate.edu/extension/presentations/publications/comm/Diffusion%20Process.pdf

[52] Annex 26 of EB meeting 68.

SECTION D. Start date and duration of PoA

D.1. Start date of PoA

>>
02/07/2007

D.2. Duration of PoA

>>
02/07/2007 – 01/07/2035
(28 years)

SECTION E. Environmental impacts

E.1. Level at which environmental impacts analysis is undertaken

>>

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

The environmental impact of a SWH system is the same as the environmental impact on Programme level. On both levels the impact is limited. The systems are installed on the premises of existing households or SME, mostly on rooftops or balcony's. The systems do not emit pollutants and use only water, providing no danger to the surrounding environment in case of leakage or malfunctioning.

Most of the positive environmental impacts result from the reduced consumption of electricity, which reduces emissions from the use of fossil fuels for power production.

A formal Environmental Impact Assessment is not required by Indian law.

E.2. Analysis of environmental impacts

>>
No environmental impact assessment is required. The environmental impacts of the Programme on the quality of air, soil or water are neutral or positive.

The Gazette of India, Extraordinary, Part-II, and Section 3, Sub-section (ii) from the Ministry Of Environment And Forests, published on 24 September 2006 lists the projects for which an Environmental Impact Assessment is required. Solar water heaters are not among the activities that requiring an EIA.

E.3. Environmental impact assessment

>>
Not applicable. An Environmental Impact Assessment is not required by Indian law.

SECTION F. Local stakeholder consultation

F.1. Level at which local stakeholder consultation is undertaken

>>

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

The PoA will be implemented in a similar manner throughout India but differences might occur between CPAs as technology providers between CPAs might differ. Stakeholder consultations can be organised for a group of CPAs if they can be demonstrated to be in similar geographic areas

and time (start of construction/implementation within the same two years), similar socio-economic situations, identical activity or technology etc.

F.2. Modalities for local stakeholder consultation

>>
n/a

F.3. Summary of comments received

>>
n/a

F.4. Consideration of comments received

>>
n/a

SECTION G. Approval and authorization

>>
The letters of approval from the DNA of India and Germany who are involved in the PoA have been granted on 10 October 2012 and 11 March 2014. Earlier, the project participant operated with a Letter of Approval from the Netherlands, dated 16 November 2011.

PART II. Generic component project activity (CPA)

SECTION H. Description of generic CPA

H.1. Title of generic CPA

>>
Solar Water Heater Program in India - "CPA-XX"

H.2. Reference number of generic CPA

>>
8855-00 [2 digit CPA number]

H.3. Purpose and general description of generic CPA

>>
The PoA will consist of CDM Program Activities (CPAs), each with a maximum number of installations up to 64,000 m^2 collector area, therefore respecting the limits for small-scale CDM activities as defined by the “Analysis and explanation of the conversion factor for solar thermal collectors” from the Small Scale Working Group[53]. The gross potential for solar water heating systems in India has been estimated at 140 million sq. m[54] of collector area.

The PoA only includes CDM Activities Type 1.

In a typical CPA, SWH systems will be installed in residential and commercial buildings throughout India (Appendix 4 contains a list of buildings included in the PoA). A SWH system utilizes solar energy for water heating. SWH will be composed of solar collectors and tanks for the heated water. Each CPA will include sales, distribution and installation of SWH systems. It will provide

[53] Value obtained from Annex 3 of the Small Scale Working Group (SSC WG) Meeting 07.
[54] MNRE (no date) *Background paper on status of solar water heating in India* (MNRE UNDP/GEF Global Solar Water Heating Project).

households and small, medium sized enterprises (SME) with in-house supply of hot water and will displace fossil fuels and carbon intensive electricity from the grid, thereby reducing greenhouse gas emissions. It will also promote commercialization of renewable energy technology.

The PoA-DD stipulates two approaches to the demonstration of additionality at CPA level. One of these approaches is demonstrating that the CPA is a micro-scale activity.

A CPA is considered a micro-scale project activity since it meets the requirements in the "Guidelines for demonstrating additionality of microscale project activities" (EB 68, Annex 26). The Guideline applies to "renewable energy technology" and includes "All technologies/measures included in approved Type I Small Scale CDM methodologies". Through item 2 of the eligibility criteria in section K., this criterion is met. According to version 04 of the guideline,[55] three criteria remain which are based on section 2.C of the guidance. For each CPA inclusion the latest version of this guideline will be applied.

3. Each of the independent subsystems in the project activity is smaller than or equal to 4500kW thermal installed capacity,
4. End users of the subsystems or measures are households, communities or SMEs.

H.4. Technologies/measures

>>

The SWH falling under this PoA consists of the following:

1. *Solar collector(s) that capture solar radiation*: A weatherproofed surface area in which fluid (generally water) is exposed to heat from the sun. Solar energy heats up the fluid causing it to circulate through the system by natural convection (thermosyphon) or the fluid is circulated with a pump. The fluid is usually passed to a storage tank located close to the collector.
2. *Storage tank*: a reservoir where the energy from the heated fluid is transferred to the cold water and where the heated water is stored until use.
3. *Fluid:* circulating fluid that absorbs the energy collected.

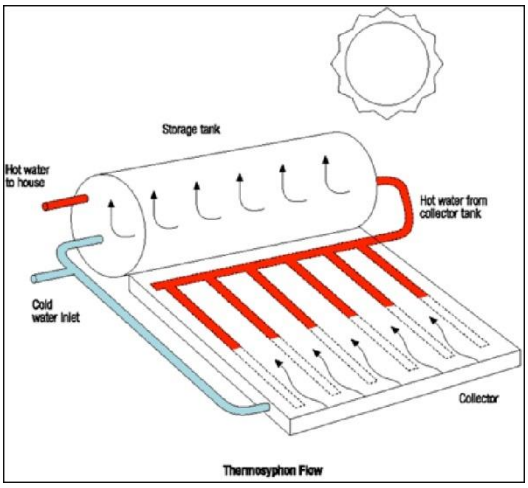


Figure 2: Solar water heating system (example with thermosyphon)

[55] Annex 26 of EB meeting 68.

Some of the technical options for a SWH include the following:

Flat Plate Collectors (FPC) In the FPC model, which is the simplest and the most common type of solar thermal device, the system works basically on a flat, blackened absorber plate inside the collector. When sunbeams are allowed to strike this plate, heat gets trapped inside the collector. This heats up the water in the copper tubes that run through the plate, causing the water to circulate through the system by natural conduction or convection. The heated water then gets transported to a storage tank placed above the collector, under well insulated conditions, for further channelling to the user point. FPC models typically have a surface area of around 2.0 m^2/100 liters.

Evacuated Tube Collector (ETC). In the ETC model, the system works on two concentric tubes made of tough borosilicate glass. The outer tube is transparent and allows sunrays to pass through it with minimal reflection. The outer surface of the inner tube is selectively coated with an ultra-efficient absorber (A1-N/A1) for maximal solar spectrum absorption and minimal heat loss. The tops of the two tubes are fused tight and all gases in the space between the two glass layers are pumped out while exposing the tube to high temperature. The resulting vacuum acts as an excellent insulator just like in a glass-lined thermos flask. ETC models typically have a surface area of around 1.5 m^2/100 liters.

Heat exchanger. The Programme also includes a type of SWH which uses a heat exchanger. In this type a fluid is heated in the collector after which the heat from the fluid is transferred to the water in a heat exchanger in the storage tank. The heat exchangers are used, for example, in cold regions, where a fluid can be used with a lower freezing point than water to prevent the water in the collector from freezing.

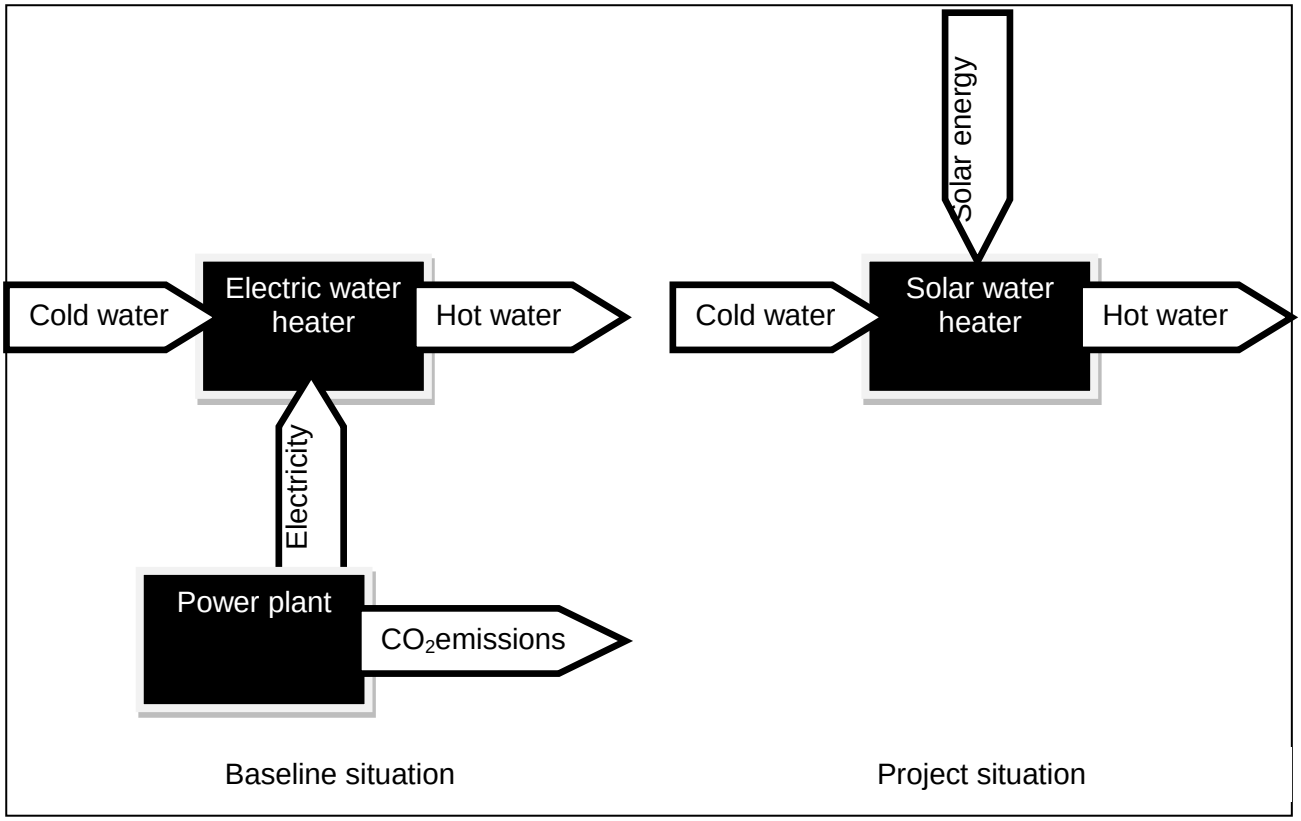
Size. The size of the systems can differ. The maximum system size is 640 m^2.

Regular/balcony models. The SWH can be regular systems, often used on rooftops, or balcony models.

SWH developers participating in the PoA are encouraged to invest in research and development for the improvement of the SWH systems that are currently being disseminated. It is also encouraged that know-how as to the design and construction and technology of SWH proven in other countries, be transferred to India. This technology transfer could be from Annex-I countries which have developed efficient technologies. Hence despite the current SWH concept described above, alternative concepts will also be applicable to the PoA, as long as they fall within the eligibility criteria as per section K. of this PoA-DD.

The average lifetime of SWHs is about 20 years[56]

[56] Based on manufacturers' specification



Flow diagram for the baseline (left) and project situation (right).

SECTION I. Application of selected methodologies and standardized baselines

I.1. Reference to methodologies and standardized baselines

>>

The SSC-CPAs will use the approved small- scale methodology AMS.I.C./Version 21 "Thermal energy production with or without electricity[57]. This is a type I methodology "Renewable energy projects"

The project makes use of the periodically updated Indian grid emission factor.

I.2. Applicability of methodologies and standardized baselines

>>

AMS I.C	Justification
This category comprises renewable energy technologies that supply users i.e. residential, industrial or commercial facilities with thermal energy that displaces fossil fuel use. These units include technologies such as solar thermal water heaters [..]	Program aims at distribution/installation of SWH in buildings (residential and commercial).
Project activities that seek to retrofit or modify an existing facility for renewable energy generation are included in this category.	The CDM SWH database keeps units which are serviced, replaced or maintained. Additional capacity from expanding existing SWHs can be

[57] Small scale methodologies are available at:
http://cdm.unfccc.int/methodologies/SSCmethodologies/approved.

	added to the CDM portfolio.
The total installed/rated thermal energy generation capacity of the project equipment is equal to or less than 45 MW thermal.	For the thermal applications of solar energy projects, "maximum output" shall be calculated using a conversion factor of 700 Wth/m^2 of aperture area of glazed flat plate or evacuated tubular collector i.e. eligibility limits in terms of aperture area is 64,000 m^2 of the collector[58]. Cumulative SWH per SSC-CPA will not exceed the limit of 64,000 m^2 aperture or collector area.[59]
The capacity limits specified [the 45MW thermal] apply to both new facilities and retrofit projects. In the case of project activities that involve the addition of renewable energy units at an existing renewable energy facility, the total capacity of the units added by the project should shall comply with capacity limits specified [..] and shall should be physically distinct3 from the existing units.	The limits for the SWH CPA as a whole (45 MW_{th}), as well as for the individual SWHs (0.45 MW_{th}), are specified in the CPA database, and ensured to be below the specified limits in a verifiable manner.

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

CPAs are exempted from the debundling check if the individual elements of the CPA have a capacity below 1% of the small scale threshold[60]. The small scale threshold defined by AMS.I-C is "the total installed thermal energy generation capacity of the project equipment, when using both fossil and renewable fuel shall not exceed 45 MW thermal". The calculation in the table below shows the proposed SWH do not individually exceed 1% of the SSC threshold, and that therefore the program is exempted from the de-bundling check.

Table 5: AMS-I.C threshold

AMS I C Threshold	1% of SSC Threshold	Capacity of an individual SWH distributed through program
45 MW_{th}	0.45 MW_{th}	maximum 640 m^2

The annual average solar radiation defined by the Small Scale Working Group is 700 W_{th}/m^2.[61] The maximum surface area of a single system in the PoA cannot exceed 640 m^2. With the given amount of solar radiation such a system would have a capacity of 0.448 MW_{th}, which is below 1% of the small-scale threshold.

I.3. Application of multiple methodologies

>>
Only AMS-I.C, version 21.0 applies.

[58] Annex 3 of SSC WG Meeting 07

[59] Annex 3 of SSC WG Meeting 07

[60] TOOL20. Methodological tool: Assessment of debundling for small-scale project activities Version 04.0, paragraph 17..

[61] Small Scale Working Group Meeting 07, Annex 3, section 5.

I.4. Project boundary, sources and greenhouse gases (GHGs)

>>

	Source	GHG	Included?	Justification/Explanation
Baseline	CO2 emissions from electricity generation in fossil fuel fired power plants that are displaced due to the project activity	CO_2	Yes	Major source of emissions
		CH_4	No	Minor source of emissions
		N_2O	No	Minor source of emissions
Project activity	CO2 emissions from power usage for pumps used in the SWH systems	CO_2	yes	According to AMS-I.C. /Version 21, paragraph 66
		CH_4	No	
		N_2O	No	

I.5. Establishment and description of baseline scenario

>>

The baseline scenario is the continued use of the systems that were used before the implementation of the SWH system. An alternative available to the project proponents that delivers a comparable level of service is the use of electric water heaters.

Baseline energy consumption

Water heating is an energy intensive activity due to significant loss of energy during heat transformation. For hot water to be available when needed, a large volume of water must be kept heated at all times. The energy consumption for hot water preparation accounts for 20-30% of the total electricity consumption by households[62], as demonstrated by table 6.

Table 6: Estimated rural and urban energy consumption per household per year (GJ) (1999-2000)[63]

Region	Income group	Cooking	Water Heating	Lighting	Others	Total	% of total energy consumed in water heating
Rural	Low Income	19.88	6.62	0.4	1.3	28.2	23.47
	Middle Income	19.09	6.26	0.87	1.5	27.72	22.58
	High Income	14.88	4.39	1.2	1.9	22.37	19.62
	Average	18.8	6.13	0.75	1.57	26.1	23.48
Urban	Low Income	14.46	4.45	1.22	3.24	23.37	19.04
	Middle Income	9.46	2.85	1.52	4.1	17.93	15.89
	High Income	7.34	0.5	2.52	5.5	15.86	3.15
	Average	10.8	2.51	1.56	4.28	19.05	13.17

Baseline Energy Source

Historical trends in household energy consumption for the period 1980-2000 indicate that many households continue to depend on traditional fuels for cooking and water heating[64]. Urban and rural India is largely dependent on non-renewable sources of energy for heating water. A UNEP-sponsored survey in India found that 90% of urban respondents relied solely on electricity to heat

[62] UNEP Riso, *Barriers to the Diffusion of Renewable Energy technologies – A case Study of the State of Maharashtra*, India (Roskilde, 2001)
[63] B. Sudhakara Reddy:*Technological Substitution and Changes in the Household Energy Consumption Pattern: A Case Study of India,* Indira Gandhi Institute of Development Research.
[64] B. Sudhakara Reddy*: Economic and social dimensions of household energy use: A case study of India*, Indira Gandhi Institute of Development Research.

water[65,66].

Baseline Technology

The baseline energy source for heating water is electricity.[67] Electric Water Heater (EWH) is a common demonstrated and tested device for water heating. The Indian EWH market reported a sale of 1.6 million units in 2007 with a total valuation of Rs 6.5 billion. The market is growing with double-digit figures annually[68]. Further, India's water heater market is projected to surpass $ 600 million by 2023 and 61 million operational units by 2020.[69] Growth in the market is led by increasing number of new residential units and other construction activities coupled with rising per capita disposable income[70].

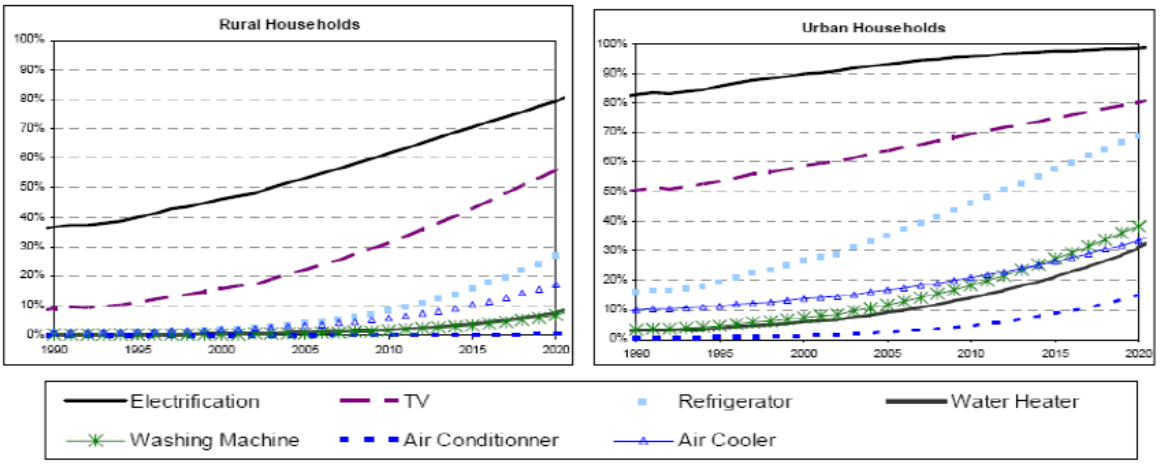


Figure 4: Projections of rate of appliance diffusion[71].

Baseline renewal

This PoA-DD is applicable to the second crediting period. This section describes how the baseline has been renewed according to the requirements of sections 11.1 and 11.2 of the PoA standard (CDM-EB93-A07-STAN v02.0). This includes and assessment of the validity of the modalities to calculate GHG emission reductions that would have resulted from the existing baseline scenario, and how to update it for each of the corresponding CPAs (para 288 and 287). Next to this, the

[65] Samuel Milton & Steven Kaufman, (2005), *Solar Water Heating as a Climate Protection Strategy: The Role for Carbon Finance*.

[66] Stephane de la Rue du Can, Virginie Letschert, Michael McNeil, Nan Zhou, and Jayant Sathaye,(2009). *Residential and Transport Energy Use in India: Past Trend and Future Outlook* (Ernest orlandolawrenceberkeley national laboratory).

[67] UNDP (2010), Solar Water heaters users handbook, available at: https://www.undp.org/content/dam/india/docs/user%E2%80%99s_handbook_on_solar_water_heaters.pdf

[68] https://www.business-standard.com/article/companies/a-o-smith-enters-india-aims-30-market-share-in-3-yrs-108091700026_1.html

[69] International Energy Studies Group (2017), Assessing the Cost Effective Energy Saving Potential from Top 10 Appliances in India

[70] TechSciResearch (2018), India Water Heater Market By Type (Electric, Solar and Gas), By Instant Vs. Storage, By Distribution Channel (Exclusive Brand Outlets, Multi-Branded Electronic Stores and Non-Store-based Retailing), Competition Forecast & Opportunities, 2013–2023, available at: https://www.techsciresearch.com/report/india-water-heater-market/3040.html

[71] Stephane de la Rue du Can, VirginieLetschert, Michael McNeil, Nan Zhou, and Jayant Sathaye,(2009). *Residential and Transport Energy Use in India: Past Trend and Future Outlook* (Ernest orlandolawrenceberkeley national laboratory).

continued validity of *data and parameters used for determining the original baseline, that were determined ex ante and not monitored during the PoA period*, should be assessed (para 291). The assessment of the assessment of the modalities to calculate GHG emission reductions should consider new and relevant mandatory national and/or sectoral policies and circumstances or conditions.

The baseline is the continued use of electric geysers to generate heat, and the baseline emission calculation relies on the grid emission factor of the Indian national grid.

This grid emission factor is an *ex-post* parameter and therefore updated with each inclusion and renewal of the baseline of a CPA. Any such update of the grid emission factor takes into account the impact of all relevant mandatory national and/or sectoral policies, including the Electricity Act 2003, National Electricity Policy and Tariff Policy and all the respective State Governments' and state regulatory commissions' policies on Renewable Energy Sector[72]. Likewise, the impact of any changes in circumstances or conditions, for example, changes in market characteristics, the availability of fuels for power generation or raw materials for developing new power generation capacity as well as the impact of electricity or fuel prices are taken into account.

All other parameters used in the calculation of the baseline emissions, are either monitoring parameters depending on survey results, values depending on CPA size, or fixed constants from applicable and valid MNRE standards, CDM documents, latest test results or even physical or mathematical constants. Also there, the baseline calculation incorporated the impact of relevant changes in polices or circumstances, or the parameters are by definition unaffected.
The *ex-post* Baseline Emission Factor Estimation based on Version 7 of Tool 07 (Tool to calculate the emission factor for an electricity system) is included in section I.6.3.
Conclusion

Hot water is required for various purposes like bathing, shaving, kitchen, clothes washing, etc. This baseline is applicable in the present project activity as the SWH will be replacing EWH. The electricity is generated by the national electricity grid, which is predominantly coal based[73].

I.6. Estimation of emission reductions

I.6.1. Explanation of methodological choices

>>
The approved baseline and monitoring methodology applied to this PoA and its CPAs is AMS-I.C. "Thermal energy production with or without electricity" (Version 21). The methodology has a number of options for the calculation of the baseline emissions, project emissions and the eventual emission reductions. These choices are:

1) The technology used for this PoA is solar water heaters. The baseline scenario is the use of electric water heaters that use electricity from the grid. To this technology paragraph 37 and 42 apply. Paragraph 2 explicitly refers to water heaters. For the grid baseline will be referred to available and national data[74] which will be checked for updates for each new monitoring report.
2) For the efficiency of the baseline systems the conservative value of 100% is used (option (c) in paragraph 42.
3) The capacity limits (para 7) apply to new SWH systems. In some cases the SWH may be a

[72] http://www.cbip.org/Policies2019/policies.aspx

[73] CO_2 Baseline Database for the Indian Power Sector User Guide Version 14.0 (March 2018) Government of India, Ministry of Power, Central Electricity Authority, page 3.

[74] Ministry of Power, the CO_2 Baseline Database for the Indian Power Sector, version 14.0, March 2018, http://www.cea.nic.in/reports/others/thermal/tpece/cdm_co2/database_14.zip

capacity addition to an existing SWH. These systems can be included according to paragraph 6 as long as the total capacity of the units added does not exceed the capacity limits in paragraph 7. Since capacity additions will be listed in the SWH database, which is the basis for each CPA, the capacity limits of the methodology will be respected. The project emissions include emissions from on-site consumption of fossil fuels and electricity, only some of the larger systems will use forced flow pumps of which the power consumption will be monitored. The consequent emissions from power usage will be based on CO_2 Baseline Database for the Indian Power Sector, following paragraph 37.

4) Leakage is relevant if equipment is the energy generating equipment is being transferred from outside the project boundaries. That is not the case as the SWH systems are newly manufactured. No second-hand installations will be used. Therefore leakage does not occur. The main monitoring parameters are different for small and large systems. For small systems the annual energy production will be determined through the number of days of operation. These systems will be referred to as Category I systems and are referred to in paragraph 82, Data / Parameter table 1 of the methodology AMS-I.C. version 21.
5) For larges systems with a capacity of over 45kW thermal , the energy consumption has to be determined with energy meters (see paragraph 82, Data / Parameter table 7, of the methodology AMS-I.C. version 21), which meter the water flow and the ingoing and outgoing temperature. These systems will be referred to as Category II systems. The General Guidelines to SSC CDM methodologies state that a thermal solar energy project shall define the capacity with a conversion factor of $700W_{th}/m^2$. For 45kW this gives 64 m^2 (Executive Board (EB) meeting 61 Annex 21, paragraph 4). Note in this respect that a system is defined as an individual system that is not physically interconnected with other SWHs.
6) For the monitoring of parameter 1 of category I systems, survey methods will be applied to determine annually the number of days that systems are operating (option (ii) for parameter 1 in paragraph 82) for systems with a collector area of up to 64 m^2. For larger systems continuous monitoring equipment will be installed which meter the total heat production and, if forced flow pumps are used, the power consumption. The emission reductions will be determined ex post by multiplying the emission factor of the baseline technology with the energy production from the SWH systems (paragraph 16 of TOOL05). In case monitoring equipments are not installed for larger systems, they will not be included for emission reduction calculations for the entire crediting period. The baseline emission factor consists of the efficiency of the geyser and the carbon emission factor of the power grid. The energy production of the project will be determined based on the installed capacity and operating days for small SWH systems.
7) For Category II systems the energy production will be metered through flow metering and metering the temperature of the water leaving the SWH system. The temperature of the ingoing water will be fixed at a conservative value of 293 K.[75] This division between small and large systems is in line with paragraph 82, parameter 1 which recommends using the annual hours of operation for systems where metering the thermal energy output is not plausible. BTU meters are expensive, with prices well exceeding the price of an average SWH system.[76]

[75] This value is conservative, For example, according to table 8 of the “User’s Handbook on Solar Water Heaters, from UNDP, 2010, this value can be as low as 6 ºC and hardly ever exceeds 20 ºC.

[76] See for example: https://dir.indiamart.com/impcat/btu-meter.html or Carremm Controls, Flow monitors - BTU meters and 5201 Series BTU meters. Documents available upon request.

I.6.2. Data and parameters fixed ex ante

Data / Parameter:	$V_{catI,n}$
Data unit:	m^3/day
Description:	Aggregated amount of water heated daily in each CPA by Category I system n
Source of data:	CPAI – (expected) aggregated water capacity of the systems installed in the CPA
Value(s) applied:	The value will vary per CPA and per SWH type
Choice of data or Measurement methods and procedures:	The water capacity of the system installed will be tailored to the needs of the user. The relation with the different SWH types is typically as follows: • FPC uses 2.08m^2 for a 100 litre/day system, • ETC uses 1.43m^2 for a 100 litre/day system. When different designs or SWH types are included in the CPA, other values may apply as well. These values are fixed ex ante for a CPA.
Purpose of data	Calculation of baseline emissions
Additional comment:	This is the sum of the total capacity of all Category I SWH systems (to be) installed in the SSC-CPA. When a CPA is included while its full capacity is not yet used, this value may increase until the full capacity of the CPA has been reached. Only then the parameter value is fixed for a CPA.

Data / Parameter:	η_{EWH}
Data unit:	%
Description:	Efficiency of an electric water heater system
Source of data:	Methodology AMS-I.C., version 21, paragraph 43.
Value(s) applied:	100%
Choice of data or Measurement methods and procedures:	This value is conservative. A 100% efficiency assumes no losses. Electric geysers always have a lower efficiency.
Purpose of data	Calculation of baseline emissions
Additional comment:	This value will only be used for category I SWH.

Data / Parameter:	TDL_y
Data unit:	%
Description:	Average technical transmission and distribution losses for providing electricity to the category II system
Source of data:	TOOL05 “Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation” (Version 03.0), page 14.
Value(s) applied:	20%
Choice of data or Measurement methods and procedures:	This is the default factor for scenario A for project or leakage electricity consumption sources.

Purpose of data	Calculation of project emissions for Category II systems.
Additional comment:	This value will be annually updated based on new publications from the Ministry of Power Central Electricity Authority.

Method 1

Data / Parameter:	**T_{in}**
Data unit:	K
Description:	Average input temperature
Source of data:	Standards from the government of India or a specific test report of the SWH model(s) used in this CPA.
Value(s) applied:	293 K (20 ºC)
Choice of data or Measurement methods and procedures:	This value is conservative, For example, according to table 8 of the "User's Handbook on Solar Water Heaters, from UNDP, 2010, this value can be as low as 6 ºC and hardly ever exceeds 20 ºC.
Purpose of data	Calculation of baseline emissions
Additional comment:	This value will only be used for category I SWH.

Data / Parameter:	**T_{out}**
Data unit:	K
Description:	Average output temperature
Source of data:	Standards from the government of India or a specific test report of the SWH model(s) used in this CPA.
Value(s) applied:	333 K (60 ºC)
Choice of data or Measurement methods and procedures:	The MNRE specifies that SWH systems can deliver hot water at 60-80 ºC. The output temperature is a design characteristics of the SWH used in India. Domestic systems are designed for an output temperature of 60 ºC while industrial systems operate on the same or often higher temperatures.[77] The assumption of 60 ºC is conservative.
Purpose of data	Calculation of baseline emissions
Additional comment:	This value will only be used for category I SWH.

Data / Parameter:	**C_w**
Data unit:	J/g/K
Description:	Specific Heating Capacity of water
Source of data:	Georgia State University, Department of Physics: http://hyperphysics.phy-astr.gsu.edu/hbase/thermo/spht.html
Value(s) applied:	4.1855
Choice of data or Measurement methods and procedures:	Physical constant.
Purpose of data	Calculation of baseline emissions
Additional comment:	-

[77] See, for example, MNRE brief on SWHs, available upon request.

Data / Parameter:	F
Data unit:	MJ/KWh
Description:	Conversion factor from MJ to KWh
Source of data:	-
Value(s) applied:	3.6
Choice of data or Measurement methods and procedures:	Conversion factor
Purpose of data	Calculation of baseline emissions
Additional comment:	-

Method 2

Data / Parameter:	Q_n
Data unit:	kWh/day/100l
Description:	Average amount of energy collected by the SWH during a Thermal Performance Test at day-time under standard conditions for 100litre water
Source of data:	Performance test reports sponsored by or following the standards from the MNRE or a relevant government authority.
Value(s) applied:	Depends on the SWH used.
Choice of data or Measurement methods and procedures:	This value will be fixed based on the latest test reports available at the time of inclusion.
Purpose of data	Calculation of baseline emissions
Additional comment:	These values may vary with each SWH type included in the CPA, but they are fixed ex ante.

I.6.3. Modalities for ex ante calculation of emission reductions

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Baseline Emissions

The baseline scenario for a CPA is that electricity is imported from the grid for water heating by consumers. To this formula (3) in the methodology AMS-I.C, version 21 applies, which states that:

$$BE_{thermal,CO2,y} = \sum_{n=1}^{n=N} \frac{EG_{thermal,n,y}}{\eta_{BL,thermal}} \times EF_{FF,CO2,y} \quad (1)$$

In which:

$BE_{thermal,\ CO2,y}$	The baseline emissions from steam/heat displaced by the project activity during the year y	(tCO_2e/year)
$EG_{thermal,y}$	The net quantity of steam/heat supplied by the project activity during the year y	(GJ/year)
$\boldsymbol{EF_{FF,CO2,y}}$	The CO2 emission factor of the fossil fuel that would have been used in the baseline plant obtained from reliable local or national data, if available, alternatively, IPCC default emission factors can be used.	(tCO_2e /GJ)
$\eta_{BL,thermal}$	The efficiency of the plant using fossil fuel that would	-

have been used in the absence of the project activity

The methodology explains in paragraph 37 that for systems replacing grid electricity, the CO_2 emission factor of the national grid can be used. Formula (2) reflects this option. As a result, the units change from GJ to MWh and the efficiency of the baseline system becomes the efficiency of an electric water heater.

Since the amount of energy produced by the SWH systems will be different for the category I systems as for the Category II systems, these values are separated in the formula. This gives:

$$BE_{thermal,CO2,y} = \sum_{n=1}^{n=N} \frac{EG_{thermal,n,y,catI}}{\eta_{EWH}} \times EF_{grid,y} + \sum_{n=1}^{n=N} \frac{EG_{thermal,n,y,catII}}{\eta_{EWH}} \times EF_{grid,y} \qquad (2)$$

In which:

$EF_{grid,y}$	The CO_2 emission factor of the Indian grid	(tCO_2e /MWh)
$EG_{thermal,n,y,\ CAT\ I,}$	The net quantity of steam/heat supplied by the project activity from Category I systems during the year y	(MWh/year)
$EG_{thermal,n,y,\ CAT\ II,}$	The net quantity of steam/heat supplied by the project activity from Category II systems during the year y	(MWh/year)
η_{EWH}	The efficiency of an electric water heater	-
N	Total number of the SWH systems	-

Calculation for category I and Category II systems

The ex ante estimated heat production by category I and category II systems can be estimated with two different methods, depending on the data availability. These are:

Method 1
The heat production will be estimated with a formula for heat production based on the output temperature of the water from the SWH. This method can be applied if there is data available from tests performed according to standards or criteria from MNRE which determine the average output temperature of the system under standard (operation) conditions.

$$EG_{thermal,n,y,catI} = \frac{V_{catI,n}(T_{out}-T_{in})\times S_{op}\times D\times C_w}{F\times 1000} \qquad (3)$$

Where

$V_{catI,n}$	Amount of water heated daily in the CPA by Category I system n	(m^3/day)
T_{in}	Average input temperature	(K)
T_{out}	Average output temperature	(K)
S_{op}	Share of systems confirmed to be operational	-
D	Number of operational days in year y	(days/year)
C_w	Specific Heating Capacity of water (default value is 4.1855)	(J/g/K)
F	Conversion factor from MJ to kWh (factor is 3.6)	(MJ/kWh)

Following the requirements from MNRE, SWH systems should be designed for the demand on the location in which they are installed. If systems are oversized, also their heat production in this programme could be overestimated. Section C shows that households face an investment barrier, making over dimensioning of systems very unlikely. If systems are undersized this will become visible in the monitoring through reduced number of days in which the SWH system was able to provide enough hot water.

For the ex ante calculation of the emission reductions for Category II the same approaches will be used. The only change is that in formula 3 the subscript “catI” will be replaced with “catII”.

Method 2

The second option is not based on the output temperature of the SWH but on the efficiency of the system. This method can be applied if there is data available from tests performed according to standards or criteria from MNRE which determine the average amount of energy collected by the solar collector, and the heat loss of the system during 24 hours or during night and day-time.

$$EG_{thermal,n,y,catI} = \frac{V_{catI,n} \times Q_n \times S_{op} \times D}{100} \quad (4)$$

Where

$V_{catI,n}$	Amount of water heated daily in the CPA by Category I system n	(m^3/day)
Q_n	Average amount of energy collected by the SWH during a Thermal Performance Test at day-time under standard conditions for 100litre water	(kWh/day/100l)
S_{op}	Share of systems confirmed to be operational	-
D	Number of operational days in year y	(days/year)

For the ex ante calculation of the emission reductions for Category II the same approaches will be used. The only change is that in formula 3 the subscript “catI” will be replaced with “catII”.

Calculation for category II systems

The ex post calculation for Category II systems is different from the ex ante calculation. The thermal meters (BTU meter) installed per unit of SWH category II will identify the amount of thermal energy (in MWh) generated by each unit per year. The thermal energy of all category II systems as recorded by the BTU meters will provide $EG_{thermal,CatII,y}$ in formula 2.

In case the thermal meters (BTU) meters are not installed, these entire Category II systems will be excluded from the calculations for Emission Reduction for the entire crediting period.

Determination of Baseline Emission Factor Estimation ($EF_{CO2,grid,y}$)

The Baseline Emission Factor Estimation based on Version 7 of Tool 07 (Tool to calculate the emission factor for an electricity system) is applied for ex-post assessment. For each CPA baseline renewal or inclusion, this Tool will be applied.

The following steps are followed, with references to the applicable paragraphs in Tool 07:

Step 1: Identify the relevant electricity systems.

The project electricity system is delineated using option 1 (Para 17) i.e (a) Option 1 which relies on a delineation of the project electricity system and connected electricity systems as published by the DNA. The above mentioned publication by the Central Electricity Authority (CEA) constitutes such an official publication of the Government of India for the purpose of CDM baselines. The grid emission factor is calculated for a unified India, which is used for estimation emission reductions for the project activity.

For the purpose of determining the operating margin (OM) emission factor (Para 25), the CO_2 emission factor(s) for net electricity imports from a connected electricity system within India has been set at 0 tCO_2/MWh. That is option a).

Following option a), for imports from connected electricity systems located in another host country(ies), the emission factor is 0 tons CO_2 per MWh (Para 26).

Step 2: Choose whether to include off-grid power plants in the project electricity system (Optional)

To calculate the operating margin and build margin (BM) emission factor option I has been selected (Para 29). This implies that only grid power plants are included in the calculation.

Step 3: Select a method to determine the operating margin (OM).

The calculation of the operating margin emission factor ($EF_{grid,OM,y}$) is based on Option a) which is Simple Operating Margin (para 38).

The simple OM method can be used only if low-cost/must run resources constitute less than 50% of the total grid generation in: 1) average of the five most recent years, or 2) based on long term averages for hydroelectricity production (Para 39,40).

In the Unified Indian Grid, the low-cost/must run resources constitute less than 50% of the total grid generation. Hence simple OM is indeed the right option.

For simple OM, the emissions factor needs to be calculated based on ex-post option as the emission factor is determined ex-post at the time of Monitoring Report. Based on the Tool, 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 proceeding 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 chosen year to calculate grid emission factor is y-1, which will be followed for throughout the crediting period. If the data of y-1 is not available on CEA website, the second option would be y-2 that will be applied. If that option is also not available, other sources will be relied upon to estimate the grid emission factor in line with the relevant tool.

Step 4: Calculate the operating margin emission factor according to the selected method.

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. Hereby Option A (Para 47) has been selected, which is calculation of the simple OM based on the net electricity generation and a CO_2 emission factor of each power unit, since the necessary data, net electricity generation and fuel consumption of each power plant is available through the data provided by the Central Electricity Authority (CEA).

The Simple OM will be calculated using the following formula (Para 48):

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

Where:

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

Step 5: Calculate the build margin (BM) emission factor.

Of the 2 options, Option 2 is selected for calculating the Build Margin (Para 72b), which is: for the first crediting period, the build margin emission factor will be updated annually, ex post, including those units built up to the year of registration of the project activity or, if information up to the year of registration is not yet available, including those units built up to the latest year for which information is available. For the second crediting period, the build margin emissions factor will be calculated ex ante, as described in Option 1 above. For the third crediting period, the build margin emission factor calculated for the second crediting period will be used.

Following to Option 1, for the second crediting period, the build margin emission factor will be updated based on the most recent information available on units already built at the time of submission of the request for renewal of the crediting period to the DOE. Hence, at the time of inclusion of a new CPA or renewal of the crediting period of existing CPA, the build margin will be fixed.

Step 6: Calculate the combined margin (CM) emissions factor.

The calculation of the combined margin (CM) emission factor ($EF_{grid,CM,y}$) is based on Weighted average CM, which is option (a) in Para 81. This is also the preferred option according to the Tool (Para 82).

The emission factor is calculated as the combination of the OM and BM emission factors. For the first crediting period this is with W_{OM} = 0.50 and W_{BM} = 0.50, for the second and third crediting periods it will be with W_{OM} = 0.25 and W_{BM} = 0.75. This is option (b) in paragraph 86. Option (a) does not apply since the project does not generate solar power, but solar heat.

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

Where,

$EF_{grid,BM,y}$ = Build margin CO_2 emission factor in year y (tCO_2/MWh)
$EF_{grid,OM,y}$ = Operating margin CO_2 emission factor in year y (tCO_2/MWh)
w_{OM} = Weighting of operating margin emissions factor (%)
w_{BM} = Weighting of build margin emissions factor (%)
w_{OM}= 0.50 w_{BM}= 0.50 for the first crediting period
w_{OM}= 0.25 w_{BM}= 0.75 for the second and third crediting period

The step-wise calculations as described above will be applied to CPAs at the time of inclusion and renewal of crediting period.
(5)

Project emissions

Some of the larger SWH in the project activity are equipped with an electric pump for a forced flow of fluid in the collector. Emissions from the use of electricity by these pumps will be accounted for as project emissions following paragraph 66 to 76 of the methodology. in this section, paragraph 68 specifies how to calculate emissions from electricity consumption and refers to the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption”. This tool has been renamed as “TOOL05: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation”. The latest version of this tool is version 03.0. Referring to paragraph 5 of this tool, Scenario A applies “electricity consumption from the grid” to which the following equation applies for project emissions:

$$PE_{EC,y,n,II} = \sum_{n=1}^{N} EC_{PJ,n,y} \times EF_{grid,y} \times (1 + TDL_y) \quad (5)$$

Where

$PE_{EC,y,n,II}$	Project emissions from electricity consumption by category II system n from the grid during the year *y*	(tCO_2e/year)
$EC_{PJ,n,y}$	Quantity of electricity consumed by the Category II system n in	(MWh/year)

	year *y*	
TDL_y	Average technical transmission and distribution losses for providing electricity to the category II system	(%)

In case the electricity meters are not installed for the pumps, the SWHs will not be accounted for Emission Reduction Calculations.

Leakage

There is no leakage from a CPA as there is no transfer of energy generating equipment from another activity.

Emission Reductions

Emission reductions are calculated as the difference between the baseline emission from displaced electricity and the sum of the project emissions (PE_y) and leakage (LE_y).

$$ER_y = BE_y - (PE_y + LE_y)^{78} \quad (6)$$

Where

ER_y	Emission reductions by the project activity during a given year *y*	(tCO_2e/year)
BE_y	Baseline emissions of the project activity during the year *y*	(tCO_2e/year)
PE_y	Project emissions of the project activity during the year y	(tCO_2e/year)
LE_y	Leakage emissions in the year *y*	(tCO_2e/year)

I.7. Monitoring plan

I.7.1. Data and parameters to be monitored

Data / Parameter:	**D**
Data unit:	days/year
Description:	Number of operational days in year y
Source of data:	Surveys among users in a CPA.
Value(s) applied	280
Measurement methods and procedures:	The amount will be determined according to the monitoring plan and applicable sampling methods.
Monitoring frequency:	Annually

[78] AMS-I.C. v21, para 81.

QA/QC procedures:	This value will only be determined for category I SWH. The value used for the ex ante calculation stems from the User's Handbook on Solar Water Heaters.[79] The value used is conservative as this is the number of "sunny days" referred to in the report. Actual figures may be higher as demonstrated by the example of Chelsea Mills Manesar on page 28). This parameter constitutes parameter 1 in AMS-I.C,, version 21. paragraph 82. This parameter constitutes parameter 1 in AMS-I.C, version 21. Paragraph 82. SWHs work 24 hours a day, without an on/off switch or are otherwise manually activated during the course of the day. It collects solar energy to heat the water in the tank constantly. As required by the methodology, converting to hourly basis, the operational hours @24 hours/day is 280 days/year x 24 hours/day = 6720 hours/year.
Purpose of data	Calculation of baseline emissions
Additional comment:	

Data / Parameter:	S_{op}
Data unit:	
Description:	Share of systems confirmed to be operational
Source of data:	Surveys among users in a CPA.
Value(s) applied	100% is applied as ex ante value.
Measurement methods and procedures:	The amount will be determined according to the monitoring plan and applicable sampling methods.
Monitoring frequency:	Annually
QA/QC procedures:	This value will only be determined for category I SWH. This parameter constitutes parameter 1 in AMS-I.C,, version 21. paragraph 82.
Purpose of data	Calculation of baseline emissions
Additional comment:	

Data / Parameter:	$EG_{thermal,\ CAT\ II,y}$
Data unit:	MWh/year
Description:	The aggregated amount of thermal energy generated by SWH category II unit n in year y (MWh)
Source of data:	BTU meter installed per unit
Value(s) applied	Differs per CPA. The ex ante volume of water is based on the capacity of the category II systems and the energy produced is calculated in the same manner as for category I systems.

[79] UNDP/GEF, User's Handbook on Solar Water Heaters (New Delhi, 2010), page 3, available at: http://mnre.gov.in/booklets/swh160910.pdf.

Measurement methods and procedures:	The amount of heat generated per unit will be measured and recorded annually. The BTU meter should be installed to measure the fluid flow on the system outlet (to avoid that water losses in the system are included). The temperature should be metered in both the inlet and the outlet of the system, to include any storage capacity that is part of the system. In case the BTU meters are not installed for the CAT II systems, these systems will not be accounted for emission reduction calculations for the entire crediting period.
Monitoring frequency:	Annual readings
QA/QC procedures:	Maintenance of BTU meters according to the requirements of the manufacturer. BTU readings will be recorded annually. Where large differences occur with previous readings, an explanation will be sought from the user and archived.
Purpose of data	Calculation of baseline emissions
Additional comment:	This value will only be determined for category II SWH. This parameter constitutes parameter 7 of AMS-I.C. version 21, paragraph 82.

Data / Parameter:	$EC_{PJ,n,y}$
Data unit:	MWh/unit/year
Description:	Quantity of electricity consumed by the Category II system n in year *y*
Source of data:	Electric meter
Value(s) applied	Differs per CPA
Measurement methods and procedures:	Some systems will have a forced flow pump installed. All systems with a pump will have a power meter installed to determine the project emissions. The meters should be installed to record the electricity consumption of all pumps in the system. The monitoring shall be continuous. In situations where these pumps are not monitored for the quantity of electricity consumed by the SWH systems, the respective SWH systems will not be included for emission reduction calculations
Monitoring frequency:	Continuous measurement and at least monthly recording
QA/QC procedures:	Maintenance of electricity meters according to the requirements of the manufacturer. Where large differences occur with previous readings, an explanation will be sought from the user and archived. Electricity meters shall be calibrated according to the "General guidelines to SSC CDM methodologies".
Purpose of data	Calculation of project emissions
Additional comment:	This is the sum of the all data collected by Electric meters of the SWH systems operating under category I and II in the SSC-CPA. This parameter constitutes parameter 4 of AMS-I.C. version 21, paragraph 82. In case SWH systems with pumps do not have electric meters installed to determine the project emissions, the respective SWH systems will not be included for emission reduction calculations too. This is a conservative approach, as the emission reductions from the systems are much higher than the project emissions from the use of flow pumps.

Data / Parameter:	$EF_{grid,y}$
Data unit:	tCO_2/MWh
Description:	The CO_2 emission factor of the Indian grid
Source of data:	CO_2 Baseline Database for the Indian Power Sector User Guide updated each year by the Government of India, Ministry of Power, Central Electricity Authority
Value(s) applied	0.8885 as ex ante value, based on version 14 of the emission factor of the Indian Grid from the Central Electricity Authority. For the ex ante calculations latest CO_2 emission factor of the Indian grid has been used.. Since this is the 2nd crediting period, wOM=0.25 and wBM= 0.75 has been applied, following *TOOL07 Methodological tool: Tool to calculate the emission factor for an electricity system* Version 07.0, paragraph 86.
Measurement methods and procedures:	Latest methodological tool to calculate the emission factor for an electricity system.
Monitoring frequency:	The carbon intensity of the grid will be annually updated as per AMS-I.D.
QA/QC procedures:	For each monitoring report the latest value for the Indian national grid baseline will be used.
Purpose of data	Calculation of baseline emissions
Additional comment:	This parameter constitutes parameter 2 in AMS-I.C,, version 21. paragraph 82.

I.7.2. Sampling plan

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The monitoring plan is based on AMS-I.C. version 21, and described the ways in which data is gathered that is needed to determine the emission reductions from each CPA individually. For details on the monitoring plan, refer to the CME manual. The sampling plan can apply to a group of CPAs as referred to in paragraph 21 of CDM-EB50-A30-STAN, Version 07.0 and CDM-EB67-A06-GUID, Version 04.

The essence of the monitoring plan is to gather data on the energy delivered by the SWH systems, which determines the amount of electricity that is saved by the programme. In addition, some of the larger installations can be equipped with forced flow pumps. The power consumption of these pumps will be measured.

The following parameters will be monitored to determine the actual emission reductions ex post.[80]

1. Continuous operation of the equipment/system[81] (including a sampling plan)

The first monitoring parameter in paragraph 82, AMS-I.C. version 21, has two components:

(i) Recording annually the number of systems operating
(ii) Estimating the annual hours of operation of an average system

Both the components of this parameter can be monitored using survey methods according to the methodology for Cat I systems.

For Cat II systems, all the SWHs will be monitored using BTU meters.

[80] AMS-I.C., version 21, paragraph 66 and 82.

[81] AMS-I.C., version 21, paragraph 82, parameter 1.

The annual sample survey of randomly selected SHWs determined statistically will capture both the above parameters. The response to the survey question as to "how many days during the last 365 days did you rely on the SWH system for hot water supply?" will capture the following:

1. If operational, the annual days of operation in a year will capture its operation on sunny days. The questionnaire estimates the days in which the system was operational, there was sufficient sunlight and the people in the premises were using the hot water produced. This excludes, amongst others, cloudy days, days when people were not present, or when the system was in repair. The result is an estimate of the number of operational days i.e. operational hours of units in a year.
2. Units that are dysfunctional or not operational, the response to the question of the number of days of operation will be zero, which will account as non-operational units and captured in the surveys. From there the proportion of units that is operational is determined.
3. The proportion of operational units which is determined through the survey will be applied to quantify the total heat generated from the capacity installed in the CPA. In effect, emission reductions will only be claimed from the share of systems which is operational. They survey results on the systems that are no longer operational, will be used to calculate the share of the capacity of the sample which is operational. Since systems vary in size, this can have a slightly different outcome from just counting the number of systems which is operational. The share of the capacity in the survey which is operational will then be used to determine the capacity, and resulting heat output and emission reductions from the whole population of SWHs in the CPA.

For example, of the sample survey shows that 98% of the surveyed capacity was operational at an average of 280 operational days. Then the emission reduction will be calculated for only 98% of the heat generated from the capacity installed in the CPA and for this average of 280 days.

Annually, a sample of owners of a category I SWH will be approached with a survey to determine to what extent their systems have been used. Key questions in this survey will be "How many days during the last 365 days did you rely on the SWH system for hot water supply?". The average outcome of the question, weighted against system size, will be used to determine annually the number of days the systems has been operating during the last year. The survey will be implemented at a sample of SWH users included in the CPA. For samples at CPA level the size will be determined with 90% confidence and 10% precision, following the EB guidance on this topic.[82] For a single sampling plan with more than one CPA, 95/10 will be followed.

Table 9: Sampling design.

Objective	Determine how many days the systems have been operating during the last year.
Reliability requirements	90/10 confidence/precision If a single sampling plan (paragraph 21 of CDM-EB50-A30-STAN) with more than one CPA is applied, this changes into 95/10.
Target population	The population of Category I SWH systems in the CPA. In case a single sampling plan is applied the population may include Category I systems in several CPAs.
Sampling method	Stratified sampling: the Category I systems will be divided in systems located in regions with relatively high radiation and systems located in regions with lower radiation. The number of days of operation shows to what extend the system can meet the supply of the user throughout the year. This differs typically depending on the latitude in which the systems are located. Whether a system is a low radiation or high radiation area will be determined according to the state in which the SWH is located, following the overview in Appendix 5 of the PoA-DD. If the results from the actual samples fail to achieve the target minimum levels of

[82] EB 69, Annex 5:Guidelines for sampling and surveys for CDM project activities and programme of activities (Version 02.0). The sampling plan in table 9 is based on section III. Recommended outline for a sampling plan.

	precision, the CPAI(s) shall perform additional data collection that is a supplemental or new sample to reach the required precision level.

Sample size	The sample size depends on the number of Category I systems located in states with relatively high solar radiation and states with relatively low solar radiation (see Appendix 5). The sample size at CPA level will be determined with equation (21) of the Guideline for sampling and surveys for CDM project activities and programmes of activities Version 4., CDM-EB67-A06-GUID, which is as follows: $n \geq \frac{1.645^2 NV}{(N-1)\times 0.1^2 + 1.645^2 V}$ Where: $V = \left(\frac{SD}{mean}\right)^2$ n = Sample size N = Total number of SWHs Mean = Mean SD = Standard Deviation 1.645= Represents the 90% confidence required For a single sampling plan applied to population that include Category I systems in several CPAs, 95% confidence will be applied. Hence 1.645 will be replaced by 1.96. Thus for a single sampling applied to several CPAs, the equation will be $n \geq \frac{1.96^2 NV}{(N-1)\times 0.1^2 + 1.96^2 V}$ Overall Standard Deviation (Equation 22): $SD = \sqrt{\frac{(g_a \times SD_a^{\ 2}) + (g_b \times SD_b^{\ 2})}{N}}$ Where: SD = Weighted overall standard deviation, SD_a is the standard deviation for SWHs in high solar radiation states and SD_b is the standard deviation for SWHs in low radiation states. g_a = size of the group in high solar radiation states g_b = size of the group in low solar radiation states N = Population total And the mean (Equation 23): mean = $\frac{(g_a \times m_a) + (g_b \times m_b)}{N}$ where: mean = weighted overall mean m_a = mean of high solar radiation states m_b = mean of low solar radiation states Further, proportional allocation to high solar radiation and low solar radiation will be done based on the proportion of the strata to the total SWHs, according to Equation 28, as follows:

$$n_a = \frac{g_a}{N} \times n \text{ and } n_b = \frac{g_b}{N} \times n$$

n_a is the sample size for high radiation and
n_b for low radiation

If one stratum has zero elements, the sampling will be done in one stratum alone. The difference between the solar radiation intensity throughout India is too small to further subdivide populations with a representation in only one stratum.

The categorisation between the strata is done based on individual SWH.

In anticipation of a certain amount of non-response the survey will include a larger sample than the minimum required according to the formula above. The factor with which the sample will be expanded will be adjusted based on experience with non-response throughout the programme. For the first survey in the first CPA a non-response of 20% or larger will be assumed.

The expected proportion will be updated based on the latest survey undertaken.

The Excel based sample size calculator available on the UNFCCC website[83] will be used to determine the sample size using the sheet "Stratified – Mean".

Reliability Calculations:

To demonstrate that the conducted sample meets the confidence and precision level, the following analysis will be made:

Based on the guideline on sampling and surveys for CDM activities and programme of activities (CDM-EB67-A06-GUID), Version 4, the calculation for level of precision will be done as follows (Equation 46):

m_{strat} ± z value x s.e. (m_{strat})

Where
m_{strat} is the stratified estimated overall mean
z value corresponding to 90% confidence level (for a single CPA) and 95% for several CPAs together
s.e. (m_{strat}) = standard error of the stratified estimated overall mean

The m_{strat} is calculated as (Equation 44)

$$m_{Strat} = \sum_{i=a}^{k} \frac{g_i}{N} \times m_i$$

Where:

m_{Strat}	=	The stratified estimated overall mean
g_i	=	Size of the i^{th} group (CPA) where i=a,…,k
N	=	Population total
m_i	=	Mean of the i^{th} group (CPA) where i=a,…,k

[83] Meth Guidance 48 calculator: https://cdm.unfccc.int/sunsetcms/storage/contents/stored-file-20150813144045237/Meth_guid48Calculator.xlsx

	The standard error of stratified estimated overall mean will be calculated as follows (Equation 47): $$s.e.(m_{Strat}) = \sqrt{\sum_{i=a}^{k} \left(\frac{g_i}{N}\right)^2 \times \left(1 - \frac{n_i}{g_i}\right) \times \frac{SD_i^2}{n_i}}$$ Eq Where: $s.e.(m_{Strat})$ = Standard error of the stratified estimated overall mean g_i = Size of the i[th] group (CPA) where i=a,…,k N = Population total n_i = Number of sampled units in the i[th] group (CPA) where i=a,…,k SD_i^2 = Variance of the i[th] group (CPA) where i=a,…,k Reliability will be calculated as follows: Reliability, expressed as a percentage, is quantified using the following equation: $$Reliability = \frac{0.5 \times Width\ of\ Confidence\ Interval}{Estimated\ Stratified\ Overall\ Mean} \times 100$$ Equation (50)
Sampling frame	The category I systems will be divided in two strata. The first consists of systems in states in states with high radiation and the second of systems in states with lower radiation (see Appendix 5).
Field measurements	The survey targets days of operation in the year before the survey is conducted. The timing therefore is not relevant. The survey will be done at least once within the monitoring period.
QA/QC	The value targeted is the number of operation days of the system. The response will be verified with verification questions. These questions are listed in Appendix 6.
Analysis	The average result for the number of days of operation in the sample will be used in the monitoring report. The results will be corrected for the size of the individual systems that were surveyed. Non-response will not be taken into account (see also: Sampling method above).
Implementation Plan	The monitoring surveys can be implemented in parallel to customer satisfaction surveys. Data collection will be performed by surveyors or local contact persons of the CMAI (s). Data processing will take place centrally by the CMAI(s) or CME by staff which is qualified to process data in excel or a different statistics processing or spread sheet programme, whose knowledge of statistics is/are at least sufficient to implement the Standard (EB 70, Annex 5).

The surveys can be combined with customer satisfaction research surveys. A CPAI may choose not to approach all owners of a category I system but survey a sample of the owners, as long as the sampling and survey approach meets the criteria in the General Guidelines for Sampling and Surveys for Small-Scale CDM Project Activities.

The survey will be performed around the end of the monitoring period for which the survey is used. If a monitoring period is more than one year and two surveys have been done for that period, the average of the two surveys will be taken.

2. Single Sampling Plan for several CPAs

According to paragraph 21 of CDM-EB50-A30-STAN, the CME can decide to apply a single sampling plan for category I systems across CPAs. This approach will apply the same approach as described in table 9 with the only change that the “target population” will be “All Category I SWH

systems implemented in a period of two calendar years". In addition, the reliability requirements will be 95/10 confidence/precision and the sample size will be determined using this criterion. The use of a single sampling plan is possible because the population of Category I systems are very homogenous, in particular with respect to the parameter sampled (days of operation). By increasing the confidence level and limiting the single sampling plans to systems implemented in a period of max 2 years, the limited variations are both reduced and recorded.

I.7.3. Other elements of monitoring plan

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1. Net quantity of thermal energy supplied by the project activity during the year y[84]

For all category II SWH, continuous monitoring will demonstrate the total amount of thermal energy supplied. For this purpose BTU meters will be installed all these systems. For systems that do not have a BTU meter installed, the energy production will be assumed to be zero.

2. CO_2 emission factor for the grid electricity in year y[85]

The carbon intensity of the grid should be annually updated.[86] For each monitoring report the latest value for the Indian national grid baseline will be used.

3. Electricity consumption by the project[87]

Some systems will have a forced flow pump installed. All systems with a pump will have a power meter installed to determine the project emissions. In case the power meter is not installed, these SWHs will not be considered for emission reduction for the entire crediting period.

SECTION J. Crediting period type and duration

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All CPAs will have a crediting period of 7 years, which can be renewed up to two times to create an overall crediting period of 21 years per CPA.

SECTION K. Eligibility criteria for inclusion of CPAs

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The eligibility criterion – Category is based on paragraph 124 of the CDM-EB93-A07-STAN – Standard CDM project standard for programmes of activities Version 02.0.

No.	Eligibility criterion - Category	Eligibility criterion - Required condition	Supporting evidence for inclusion
1	(a) Geographical boundaries	All SWH listed in the proposed SSC-CPA must be within the geographical boundary of India.	The address at which all SWHs are installed, and the state, is recorded in the order form and invoice. The database can only include addresses and states in India.
2	(d) Specifications of technology/ measure	The technology used under the proposed SSC-CPA consists of a solar energy based water heating system.	The technology that can be used in the CDM project is described in section A.4.2.1. It allows for the use of technologies other than the ETC and FPC systems described there.

[84] AMS-I.C., version 21, paragraph 82, parameter 5.

[85] AMS-I.C., version 21, paragraph 65.

[86] TOOL05, version 03.0, section 72.

[87] AMS-I.C., version 21, paragraph 65.

No.	Eligibility criterion - Category	Eligibility criterion - Required condition	Supporting evidence for inclusion
3	(k) small-scale or microscale threshold	The aggregated surface of the collectors of all systems in the CPA should not exceed 64,000 m^2.[88]	The total surface area of the SWHs will be recorded as part of the CME's database, derived from the installation record. .
4	(f) compliance with the applicability of the applied methodologies	The SSC-CPA follows the baseline and monitoring methodology AMS-I.C. version 21 and should meet its eligibility criteria as discussed in section B.2. of Part II.	The eligibility criteria include that the technology employed are solar water heaters (already covered above), and that the total installed/rated thermal energy generation capacity of the project equipment stays below the small-scale limit of 64,000 m^2.
5	(l) requirements for the debundling check	The SWH collector area of an individual system should not be more than 640 m^2.	The size of each system will be recorded in the order form and installation form entered into the CME database. In the SWH database, which will be used to show the SWH in each CPA as well, a dedicated cell will select the SWH with the largest surface area. This allows for easy checking that the surface stays below 640m^2. Cross-checks will be performed to ensure that the actual SWH capacity corresponds with that recorded in the database.[89]
6	(c) CPAs are neither registered as CDM project activities, included in another registered PoAs	Confirmation that this SSC-CPA, nor any of its SWH systems is not yet registered and not being registered as a standalone CDM project by ensuring that the CPAI has the full title over the emission reductions generated by the SWH users listed in the CPA. To confirm this, all owners of the SWH systems in the CPA should have transferred the title to the emission reductions to the CME, either directly or through the CPAI.	Ensure that each SWH owner participating in the PoA signs an agreement in which it ultimately transfers the title to the emission reductions to the CPAI or CME. This agreement can be part of the sales contract. Ensure that each CPAI signs an agreement with the CME before its participation in the PoA in which its commits to signing similar agreements with Nuetech. For CPAIs other than Nuetech the title to the CERs can be transferred to Nuetech directly or through the CPAI, as long as ultimately the title rests with Nuetech.
7	(b) Conditions to avoid double counting	Each SWH in the SSC-CPA shall be uniquely identified and defined in an unambiguous manner by providing the address, and/or the system serial number of the collectors installed at each location.	The address and serial numbers should be collected at completion of the sales agreement and invoice and entered into the centralised database. Data entry for serial numbers can easily be checked for repetition by ranking on serial numbers.
10	(e) conditions to check start dates	The start date of the CPA is not after the date of delivery or construction of the first SWH installed. Documented evidence is available to confirm that date. For example an invoice, installation or delivery form	Invoice dates should be recorded in the SWH database. The earliest data will define the start date of the CPA. Ranking the database on date allows for easy checking.

[88] Value obtained from Annex 3 of the Small Scale Working Group (SSC WG) Meeting 07.

[89] These cross-checks will be implemented from CPA-2 onwards.

No.	Eligibility criterion - Category	Eligibility criterion - Required condition	Supporting evidence for inclusion
11	(g) demonstration of additionality (i) target group	The CPA is additional according to the criteria for confirmation of additionality for its inclusion into the PoA in section C.	Depending on the method used to demonstrate additionality a record of the following will need to be kept: *Option 1: Off-grid activity* that the market penetration of SWH in households does not exceed 33% on state level, as substantiated by latest publications from, commissioned or funded by the Indian government at the time of CPA implementation. Demonstration that there are no legal obligations to use SWH for water heating in states where the SWH in the CPA are located. *Option 2: Micro-scale* – 1. Each of the independent subsystems in the project activity is smaller than or equal to 4500kW thermal installed capacity, 2. End users of the subsystems or measures are households, communities or SMEs (Tool 19, v08.0).
12	(h) affirmation on funding from Annex I Parties	A confirmation that no funding from Annex 1 parties has been used for this CPA or that, if used, this did not result in a diversion of official development assistance.	Confirmation will have to be provided as part of the CPA-DD.
13	Stakeholder consultation	Stakeholder consultations can be organised for a group of CPAs if they can be demonstrated to be in similar geographic areas and time (start of construction/ implementation within the same two years), similar socio-economic situations, identical activity or technology etc.	Stakeholder consultation minutes, or a confirmation from the CME/CPA Implementer that the meeting is conducted.
14	Leakage	Leakage is not relevant since there is no energy generating equipment transferred from outside the project boundaries and no second-hand installations will be used in the project.	Confirmation by the CME/CPA Implementer that no second-hand installations have been used in the project.

Appendix 1. Contact information of coordinating/managing entity and project participants

Coordinating/managing entity and/or project participants	☒ Coordinating/managing entity ☐ Project participant
Organization name	Nuetech Solar Systems Pvt. Ltd
Country	India
Address	P.B.#9167, B.M.Shankarappa Indl. Estate, Sunkadakatte, Magadi Main Road, Bangaluru – 560 091, India
Telephone	+91-80-2348-3766
Fax	+91-80-2328-1730
E-mail	ceo@nuetechsolar.com
Website	http://www.nuetechsolar.com
Contact person	Mr. Tyamagundlu

Coordinating/managing entity and/or project participants	☐ Coordinating/managing entity ☒ Project participant
Organization name	Carbonbay GmbH & Co. KG
Country	Germany
Address	Große Theaterstr.14, 20354 Hamburg
Telephone	+491733412363
Fax	-
E-mail	registry@carbonbay.com
Website	
Contact person	Mr. Wolfgang Bruekner

Appendix 2. Affirmation regarding public funding

No public funding or ODA have or will be diverted for the implementation of the PoA

Appendix 3. Applicability of methodologies and standardized baselines

Please refer to Section B of this PoA-DD

Appendix 4. Further background information on ex ante calculation of emission reductions

List of building types included in PoA

Commercial	**Educational**	**Government**	**Religious**	**Residential**

buildings	buildings	buildings	buildings	buildings
Bank	Amphitheatre	Capitol	Church	Apartment block
Bar	Art Gallery	City hall	Basilica	Asylum
Pub	Cinema	Consulate	Cathedral	Condominium
Casino	College	Courthouse	Duomo	Dormitory
Coffee house	Concert hall	Embassy	Chapel	Duplex
Convention centre	Classroom building	Fire station	Fire temple	House
Forum	Dormitory	Other	Function halls	Nursing home
Hotel	Gymnasium	Palace	Gurdwara	Other
Motel	Student's union	Parliament	Imambargah	
Market	School	Policy station	Martyrium	
Nightclub	Library	Post office	Mosque	
Jazz club	Museum	Prison	Mihrab	
Office building	Opera house		Monastery	
Other	Other		Mothraeum	
Restaurant	Symphony		Oratory	
Skyscraper	Theatre		Other	
Shop	University		Pagoda	
Retail store			Shrine	
Shopping mall			Synagogue	
Stock exchange			Temple	
Supermarket				
Warehouse				

List of banks/ financing institutions participating in solar water heating program

Participating	Not Participating
Public Sector Banks	
Canara bank	United Bank of India
Bank of Maharashtra	Allahabad Bank
Union bank of India	UCO Bank
Syndicate bank	Bank of Baroda
Punjab & Sind bank	State Bank of Travancore
Punjab national bank	State Bank of Patiala
Andhra bank	State Bank of Saurashtra
Vijya bank	Central Bank of India
Dena bank	State Bank of Bikaner & Jaipur
Bank of India	State Bank of Hyderabad
Oriental Bank of Commerce	Indian Bank
Corporation Bank,	Indian Overseas Bank
J & K Bank	State Bank of India (SBI)
	State Bank of Indore
	State Bank of Mysore
NBFC	
IREDA	Total 315[90]
Nagarjuna Credits & Capital Ltd	
SREI Infrastructure Finance Ltd	

[90] List of institutions: http://rbidocs.rbi.org.in/rdocs/Publications/PDFs/59260.pdf

Bhonsale Leasing Finance Co. Ltd	
Madhya Pradesh Financial Corporation	
Private Bank	
Ratnagar bank Ltd	Yes Bank
The United Western Bank Ltd.	Axis Bank
	Bank of Rajasthan
	Catholic Syrian Bank
	City Union Bank
	Development Credit Bank
	Dhanalakshmi Bank
	Federal Bank
	HDFC Bank
	ICICI Bank
	IndusInd Bank
	ING Vysya Bank
	Jammu & Kashmir Bank
	Karnataka Bank
	KarurVysya Bank
	Kotak Mahindra Bank
	Laxmi Vilas Bank
	Nainital Bank Ltd
	Ratnagar Bank
	SBI Commercial and International Bank
	South Indian Bank Ltd
	Tamil Nadu Mercantile Bank
Co-operative banks	
Nagpur Nagrik Sahkari Bank Ltd	300+ Cooperative Banks
Jalgaon Janata Sahkari Bank Ltd	
Kalyan Janata Sahkari Bank Ltd	
Solapur Janata Sahkari bank Ltd	
Akola Janata Commercial Co-op. Bank	
The Akola Urban Co.Op. Bank Ltd',	
ParvaraSahkari bank Ltd	
Cosmos Co-operative Bank Ltd	
ShikshakSahkari bank Ltd	
Ichalkaranji Co-operative bank Ltd	
MarathwadaGramin Bank	

Appendix 5. Solar radiation levels per state for stratified sampling

The solar radiation in India differs per state. For solar panels the Global Horizontal Solar Resource from the NREL gives an overview of the radiation per state. This overview hence provides a good basis to separate India in two strata, each with a different solar radiation level.

For the division of states in two strata we looked at the NREL Global Horizontal Solar Resource map from 16/08/2010 (available at the MNRE web-site: http://mnre.gov.in/sec/solar-assmnt.htm). To distinguish the states with relatively high radiation from the ones with lower radiation levels we looked at the location of the state capitals. Note however, that the difference between the high and low radiation area is relatively small. The high radiation areas typically receive 5.5-6.0 kWh/m2/day and the low radiation areas between roughly 4.5 and 5.5. This is based on Direct Normal Radiation,[91] assuming a surface area directed at the sun.

High radiation	**Low radiation**
Andaman and Nicobar Islands	Arunachal Pradesh
Andhra Pradesh, Telangana	Assam
Dadra and Nagar Haveli	Bihar
Daman and Diu	Chandigarh
Goa	Delhi (National Capital Territory of)
Gujarat	Ghaziabad
Karnataka	Haryana
Kerala	Himachal Pradesh
Lakshadweep	Jammu and Kashmir
Madhya Pradesh	Jharkhand
Maharashtra	Manipur
Pondicherry	Meghalaya
Rajasthan	Mizoram
Tamil Nadu	Nagaland
	Orissa
	Punjab
	Sikkim
	Tripura
	Uttar Pradesh
	Uttarakhand
	West Bengal

[91] Dr. Vashishtha (2012), Differentiate between the DNI, DHI and GHI?, available from: https://firstgreenconsulting.wordpress.com/2012/04/26/differentiate-between-the-dni-dhi-and-ghi/

Appendix 6. Further background information on monitoring plan

MONITORING INFORMATION

CLIMATEFOCUS

Survey questions

The survey will include the following questions. The answer to question 1 will determine the value used for monitoring parameter D, Number of operational days in year y (days/year). These questions may be part of a larger survey, for example to determine the level of customer satisfaction.

1. How many days during the last 365 days did you rely on the SWH system for hot water supply?

_____ days (fill in a value between 0 and 365)

2. Indicate the reasons why the system was not operational and how many days the system was not used because of this reason. You can fill in more than one reason.

☐ these days there was not enough sunshine _____ days

☐there was nobody at home at these days _____ days

☐the system broke down and did not work during these days _____ days

☐the system was undergoing maintenance during these days _____ days

☐the system was moved to a different location during these days _____ days

☐Other reason: _____ _____ days

☐Other reason: _____ _____ days

Total number of days (total of the above) _____ days

Please verify that the total number of days filled out in question 1 and the total in question 2 add up to 365 days.

Appendix 7. Summary report of comments received from local stakeholders

Appendix 8. Summary of post-registration changes

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Document information

Version	*Date*	*Description*
09.0	31 May 2019	Revision to: • Ensure consistency with version 02.0 of the "CDM project standard for programmes of activities" (CDM-EB93-A07-STAN); • Make editorial improvements.
08.1	28 June 2017	Revision to: • Remove a duplicated instruction; • Make editorial improvement.
08.0	7 June 2017	Revision to: • Improve consistency with the "CDM project standard for programmes of activities" and with the PDD and CPA-DD forms; • Make editorial improvement.
07.0	25 May 2017	Revision to: • Ensure consistency with the "CDM project standard for programmes of activities" (CDM-EB93-A07-STAN) (version 01.0); • Incorporate the "Programme design document form for small-scale CDM programmes of activities" (CDM-SSC-PoA-DD-FORM); • Make editorial improvement.
06.0	15 April 2016	Revision to ensure consistency with the "Standard: Applicability of sectoral scopes" (CDM-EB88-A04-STAN) (version 01.0).
05.0	9 March 2015	Revision to: • Include provisions related to choice of start date of PoA; • Include provisions related to delayed submission of a monitoring plan; • Provisions related to local stakeholder consultation; • Add exception for generic CPA where technology is under positive lists; • Make editorial improvement.
04.1	5 August 2014	Editorial revision to correct the document information table.

Version	*Date*	*Description*
04.0	25 June 2014	Revision to: • Include the Attachment: Instructions for filling out the project design document form for CDM programme of activities (these instructions supersede the Guideline: Completing the programme design document form for CDM programme of activities (Version 04.0)); • Include provisions related to standardized baselines; • Add contact information on a responsible person(s)/ entity(ies) for the application of the methodology (ies) to the PoA in B.4 and Appendix 1; • Add general instructions on post-registration changes in paragraphs 2 and 3 of general instructions and Appendix 6; • Change the reference number from F-CDM-PoA-DD to CDM-PoA-DD-FORM; • Make editorial improvement.
03.0	3 December 2012	EB 70 Revision to reflect changes to the *Guideline: Completing the programme design document form for CDM programmes of activities* (EB 70, Annex 6).
02.0	13 March 2012	EB 66 Revision required to ensure consistency with the "Guidelines for completing the programme design document form for CDM programmes of activities" (EB 66, annex 12).
01.0	27 July 2007	EB 33, Annex 41 Initial publication.

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