CLEAN DEVELOPMENT MECHANISM

AMS-I.J.

Small-scale Methodology

Solar water heating systems

Version 02.0

Sectoral scope(s): 01

United Nations
Framework Convention on
Climate Change

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1. Introduction

1. The following table describes the key elements of the methodology:

Table 1. Methodology key elements

Typical project(s)	The installation of residential and commercial solar water heating (SWH) systems for hot water production
Type of GHG emissions mitigation action	Renewable energy: Displacement of electricity or fossil fuel that would otherwise have been used to produce hot water

2. Scope, applicability, and entry into force

2.1. Scope

2. This category comprises the installation of residential[1] solar water heating (SWH)[2] systems and commercial[3] SWH systems for hot water production. The SWH systems displace electricity or fossil fuel that would otherwise have been used to produce hot water.

2.2. Applicability

3. There are two types of projects included in this category: retrofits and new construction.

4. Commercial SWH systems shall include operational indicators that may be easily interpreted by the intended users of the systems and that indicate that water is being heated by solar energy. The minimum requirement for such an indicator is a visible temperature display (thermometer) on the solar preheat storage tank. The thermometer does not require calibration.

5. For residential and commercial SWH projects, the hot water consumption rate and temperature at which the hot water is supplied to the load (for example, 40 litres per day at 40^{o}C), that occur during the crediting period are used to determine emissions savings. The consumption rate (and temperature) is the rate (and temperature) of water actually utilized (for example, for personal washing or for an industrial process) and is not the rate (and temperature) at which hot water is produced, which may be greater than the rate (and temperature) of consumption.

[1] For the purposes of this methodology, with respect to determining which emission reductions calculation and monitoring options are applicable, a residential SWH system is defined as one that: (a) Heats water to be used for domestic purposes only (e.g. bathing, cooking, clothes washing, etc.); (b) Is installed to serve one or more residences; and (c) Has a maximum stand-alone (independent) collector area of 100 m^2. Please also refer to Appendix for further explanation.

[2] For the purposes of this methodology, a SWH system includes the back-up water heating system and any energy-consuming auxiliary equipment, e.g. pumps and controls.

[3] For the purposes of this methodology, a commercial SWH system is defined as one that is not a residential SWH system. Commercial systems include commercial buildings, industrial facilities, hospitals, schools, etc.

2.3. Entry into force

6. The date of entry into force is the date of the publication of the EB 100 meeting report on 31 August 2018.

2.4. Applicability of sectoral scopes

7. For validation and verification of CDM projects and programme of activities by a designated operational entity (DOE) using this methodology, application of sectoral scope 01 is mandatory.

3. Normative references

8. Project participants shall apply the "Guideline: General guidelines for SSC CDM methodologies", "TOOL21: Demonstration of additionality of small-scale project activities" and "TOOL19: Demonstration of additionality of microscale project activities" available at: <http://cdm.unfccc.int/Reference/Guidclarif/index.html#meth> and <https://cdm.unfccc.int/Reference/tools/index.html> mutatis mutandis.

9. This methodology also refers to the latest version of the following approved standards and methodologies:

   (a) "Standard: Sampling and surveys for CDM project activities and programme of activities";

   (b) "AMS-I.D.: "Grid connected renewable electricity generation".

4. Definitions

10. The definitions contained in the Glossary of CDM terms shall apply.

11. For the purposes of defining baselines and other requirements the following definitions apply:

   (a) Retrofit projects are SWH project(s) that replace existing electric or fossil fuel based water heating system(s) in existing facility(ies);

   (b) New construction projects are: (i) SWH project(s) installed in new facility(ies); (ii) SWH project(s) installed in existing facility(ies) that, prior to the project implementation, do not have installed water heating systems; (iii) SWH project(s) installed in existing facility(ies) which require water heating capacity expansions; or (iv) Replacement of failed solar water heating system(s). This methodology is applicable if it is shown (as per paragraph 20) that for new construction projects, conventional electric or fossil fuel based water heating system(s) would have been installed in the absence of the project activity.

5. Baseline methodology

5.1. Project boundary

12. The physical, geographical site of the SWH system delineates the project boundary. The boundary also extends to the facility or facilities consuming the heated water generated by the SWH system.

5.2. Additionality

13. Additionality is demonstrated using one of the options below:

5.2.1. Option 1 (Positive list)

14. For installation of SWH systems, demonstrate ex-ante that the penetration[4] of the proposed project technology (solar water heaters) is equal to or less than 5 per cent of the technologies/ measures providing similar services in the relevant sector and application (i.e. Residential/commercial and retrofit/new construction) in the region[5] in order to be considered as automatically additional.

15. The penetration shall be determined using one of the following options:

    (a) Official statistics or reports, relevant industry association reports or peer-reviewed literature;

    (b) Results of a sampling survey conducted by project participants or a third party as per the latest version of "Standard: Sampling and surveys for CDM project activities and programme of activities"; covering technologies/measures providing similar services besides project technology/measure;

16. To determine the penetration using the above paragraph, the most recent data available at the time of submission of the CDM-PDD or CDM-CPA-DD for validation/inclusion, shall be used, and the data vintage used shall not include data older than three years prior to: (a) the start date of the CDM project activity; or (b) the start of validation/inclusion, whichever is earlier.

5.2.2. Option 2

17. Demonstrate additionality by applying the "TOOL21: Demonstration of additionality of SSC project activities".

5.2.3. Option 3

18. Demonstrate additionality by applying the "TOOL19: Demonstration of additionality of microscale project activities".

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[4] Refers to proportion of stock of functional equipment at the user end; also, termed as market saturation.

[5] Region/ Applicable geographical area - should be the entire host country. If the project participants opt to limit the applicable geographical area to a specific geographical area (such as province, region, etc.) within the host country, then they shall provide justification on the essential distinction between the identified specific geographical area and rest of the host country.

5.3. Baseline

19. For retrofit projects, the baseline system(s) are the operating water heating system(s) and fuel source (fossil fuel or electricity) that existed immediately prior to the start of the SWH project activity.

20. For new construction projects, the baseline system and fuel source (fossil fuel or electricity) assumed to be used for water heating is one that is demonstrated to be typical of new construction, for the given project activity as defined in paragraph 11(b), in the region of the project activity at the time of the start of the project activity. Such demonstration shall include that typical water heating systems in the project region are not solar water heating systems. The relevant requirements in the "General guidelines to SSC CDM methodologies" shall be followed.

5.4. Emission Reductions

21. Emission reductions are calculated as the energy savings that result from the project implementation multiplied by an emission factor for the electricity and/or fossil fuel displaced. For calculating the emission factor for displaced fossil fuels, reliable local or national data shall be used. IPCC default values shall be used only when country or project specific data are documented to be either not available or not reliable. For the emission factor for displaced electricity, an annual emission factor shall be calculated, in accordance with the provisions in AMS-I.D. "Grid connected renewable electricity generation" (tCO_2/MWh).

22. Energy savings that result from the project implementation shall be determined using one of following methods[6] and the choice of a method shall be made ex ante and specified in the PDD and cannot be changed during the crediting period. These three are not presented in order of preference. Project developers shall select one of these methods based on the following guidelines:

    (a) **Model based method:** this approach is only applicable to residential SWH system. The following procedures shall be followed:

        (i) An approved,[7] computerized simulation model is used to determine the annual performance of the baseline system(s) and the project system(s) in order to calculate baseline energy use and project energy use;

        (ii) Model input parameters shall include: (a) Characteristics of the baseline system including the fossil fuel or electricity input and output capacity, water

[6] Please also refer to the Appendix for further explanation

[7] Criteria for approval of computerized simulation model programs include: (a) The program is non-proprietary and available at no cost or for a small cost; (b) The simulation algorithms are available and documented; (c) Reliable and documented historical and real time weather data, compatible with the program, are available for the country were the project(s) are implemented; and (d) The program has been tested and bench marked to show that it is reliable and the results of such testing/bench marking in the public domain; and user support is available. At the time of approval of this version of this methodology, the only pre-approved model simulation program is RET Screen (<http://www.retscreen.net/>). Submittals may be made for requesting revision of this methodology to include other programs.

heating system efficiency, and storage tank size and insulation; (b) Temperature of water entering the water heating system (e.g., ground water temperature) and average end-use hot water temperature (°C) and consumption, (litres per day);[8] (c) Characteristics of the project system including solar collector size and technical and thermal performance ratings[9], collector orientation, back-up system characteristics, pumping system characteristics, and storage tank size and insulation, and (d) Solar radiation data, i.e. daily or monthly average daily solar insolation data (kwh/m^2/day) and ambient temperature data, i.e. daily or monthly average daily values (°C).[10] All model input parameters shall be included in the PDD as well as the output generated by the model;

(iii) The computerized simulation model shall be used to calculate the baseline and also the project fossil fuel and/or electricity consumption on an annual basis;

(iv) If more than one SWH system is installed as part of the project, the temperature of water entering the water heating systems, solar insolation data, and ambient temperature data that are representative of average data for all project systems, can be used. Model input parameters for baseline and project systems must be based on the characteristics of each individual system;

(b) **System metering method:** this approach is applicable to both residential and commercial SWH system projects. In the case of commercial installations, only this method is applicable:

(i) Energy content (flow rate integrated with temperature difference between inlet and outlet water temperature) of consumed/utilized hot water delivered by the project SWH system(s) to the end uses[11] within the boundary is measured and integrated, at least once every minute by a thermal meter and recorded on a daily basis. This energy content, on at least a monthly basis, is used to calculate the equivalent amount of energy that would have been consumed in the baseline system (fossil fuel or electricity) to heat an equivalent amount of useful hot water;

(ii) Fossil fuel and/or electricity use of project SWH system is continuously measured and recorded at least monthly for electricity, liquid or gas fuels and daily for solid fuels. The energy use of project auxiliary loads, e.g. for pumps and controls, is also measured continuously and recorded at least monthly. In lieu of measurement, the energy use of auxiliary loads may be stipulated

[8] Water consumption per day shall be assumed to follow a typical daily, per hour, pattern that can reasonably be shown to be typical for the residence(s) for which the project SWH system(s) will serve.

[9] According to national or international standards, e.g. the Solar Rating and Certification Corporation certification, rating, and labelling program for solar collectors and complete solar water heating systems.

[10] Insolation and ambient temperature data must be obtained from globally accepted data sources, e.g. data published by the National Aeronautics and Space Administration (NASA) or the National Renewable Energy Laboratory (NREL). Data can be used only if they are for a location that can be demonstrated to be representative of the project location.

[11] Energy content is measured for hot water delivered to loads (end uses), not to storage.

based on the rated power consumption rate and metered or conservatively estimated auxiliary load run-time(s), if such loads can be shown to be less than 10 per cent of the annual project energy consumption;

(iii) The difference between baseline and project fossil fuel, and/or electricity consumption is calculated as the energy content of the consumed/utilized project hot water delivered by the project SWH system divided by the efficiency of the baseline water heating system minus any fossil fuel and/or electricity consumption of the project system. The efficiency of the baseline system can be based on documented measurements of the baseline system (for retrofit projects), or specifications provided by manufacturers (for new construction projects), or a default value of 90 per cent;

(iv) This method ignores energy savings associated with water storage losses in baseline, as these are not substantively reduced by a SWH system;

(v) In cases where this method is applied to residential SWH systems, if more than one SWH system is installed in the project, the energy savings from all of the systems can be determined from a statistically valid sample of residences where the systems are installed. The sampling design shall take into account occupancy and demographic differences, as per the relevant requirement for sampling in the "General guidelines for sampling and surveys for SSC project activities";

(c) **Stipulated energy saving method:** this method is only applicable to residential SWH system projects that displace electricity for water heating. There are two allowable stipulated energy savings values:

(i) For applications that can be reasonably demonstrated to have substantial hot water consumption demand year-round: a single value of 450 kWh/year per square meter of collector area is stipulated for energy savings and is based on 5 kWh/m^2/day solar resource, 25% solar water heater efficiency, and 365 days/year of hot water use;

(ii) For applications that cannot be reasonably demonstrated to have substantial hot water consumption demand year-round:[12] a single value of 300 kWh/year per square meter of collector area is stipulated for energy savings.

23. The appropriate value is multiplied by the aggregate collector area verified to have been installed by the project activity. This method is applicable only when all the following conditions are satisfied:

(a) Individual solar collector area per system is less than or equal to eight square meters per residential unit (e.g. eight square meters for a single-family residence or 32 square meters for a four-unit apartment building);

(b) The tilt and orientation of the solar collectors shall be +/- 45 of due-equator and a tilt +15 to -25 degrees of latitude;

[12] Such applications can be residences that are temporary or seasonal housing or located in regions with very hot summers, for example, during which season(s) there is no or limited demand for hot water.

(c) Thermal storage volume (preheat tank volume) is either: (a) At least 50 litres per square meter of collector area; or (b) Adequate to bridge time gap between solar supply and load demand during an average winter day for a typical installation, as demonstrated by calculation or model;

(d) The sizing calculations of the SHW systems are documented to be such that the average annual, daily amount of water heated by the SWH systems is less than or equal to the average annual, daily hot water demand for a typical installation;

(e) There must be no shading of the solar collectors between 10 am to 2 pm on the shortest day of the year at the time of installation;

(f) The quality and performance of the solar collectors and SHW systems shall meet the criteria in the OG100 standard at <www.solar-rating.org>, or equivalent national or international standard, or the requirements given below:

(i) Unglazed collector must be stabilized against UV degradation;

(ii) Glazed collector must have at least one glass cover and be insulated on the sides and back to achieve a loss coefficient not more than 5 W/m^2C;

(iii) Evacuated tube collector must maintain vacuum insulation between absorber and ambient.

24. Displaced electricity can include technical grid losses (transmission and distribution) for the grid serving the locations where the project SWH system(s) are installed. This value shall not include non-technical losses such as commercial losses (e.g. theft/pilferage). The average annual technical grid losses shall be determined using recent, accurate and reliable data available for the host country. This value can be determined from recent data published either by a national utility or an official governmental body. Reliability of the data used (e.g. appropriateness, accuracy/uncertainty, especially exclusion of non-technical grid losses) shall be established and documented by the project participant. A default value of 10% shall be used for average annual technical grid losses, if no recent data are available or the data cannot be regarded accurate and reliable.

5.5. Leakage

25. If the project equipment is transferred from another activity and/or baseline equipment is not destroyed, leakage is to be considered.

6. Monitoring methodology

26. Within three months of installation each SWH system shall be inspected and undergo acceptance testing (commissioning) for proper operation in compliance with manufacturer specifications. Acceptance testing shall be documented and confirm system operation, per design specifications, and change-of-operating modes over a range of typical operating conditions. The installation date of each SWH system shall be recorded.

27. For residential SWH systems, in any given year, emission reductions can only be claimed for systems that are demonstrated to be operational and in compliance with manufacturer-required maintenance procedures, on an annual or biennial (every other year) basis during the crediting period. When biennial inspection is chosen, following the inspection and acceptance testing during the year of project installation, the inspections can be done in

years 3, 5, 7, etc. and the results of such inspections can be applied to crediting years 3 and 4, 5 and 6, 7 and 8, etc. Compliance with this requirement shall be implemented via an inspection of systems and review of maintenance records. A statistically valid sample of the residences where the systems are installed can be used to determine the percentage of systems operating and in compliance with manufacturer-required maintenance procedures. Such sampling shall take into consideration occupancy and demographics differences, as per the relevant requirement for sampling in the "General guidelines for sampling and surveys for SSC project activities".

28. When biennial inspection is chosen a 95% confidence interval and 5% margin of error shall be achieved for the sampling parameter. On the other hand, when the project proponent chooses to inspect annually, a 90% confidence interval and 10% margin of error shall be achieved for the sampling parameter.

29. For commercial SWH systems, in any given year, emission reductions can only be attributed to systems that are demonstrated to be operational and in compliance with manufacturer- required maintenance procedures on at least an annual basis during the crediting period. Compliance with this requirement shall be checked via inspection of systems and review of maintenance records.

30. When the model based method is used, the hot water load profile and consumption rates may be determined from at least 30 days of monitoring, taking into account seasonal variations in hot water use. This determination may be done once during the first year of project operation, for example, using a temporary flow measuring device. If more than one SWH system is installed in the project, the average hot water load profile and consumption rate may be determined from a statistically valid sample of the residences where the SWH systems are installed. The sampling design shall take into account occupancy and demographic differences, as per the relevant requirement for sampling in the "General guidelines for sampling and surveys for SSC project activities". In lieu of such metering, regional or national per occupant or per residence values may be used from reliable sources, not to exceed a value of 40 litres per day of hot water consumption per full time resident occupant.

31. When the system metering method is used, metering of required parameters shall be carried out with calibrated instrumentation, as per the "General guidelines to SSC CDM methodologies". All data collected shall be recorded at least monthly.

32. When the system metering method is used, metering of energy consumption for water heating or fluid pumping shall be carried out with devices that measure only the energy consumption associated with the project or baseline system. For example, energy meters can be used for electricity consumption and flow meters for fossil fuel consumption (e.g. for propane, fuel oil, or natural gas). A cumulative energy (kJ) meter which multiplies flow and temperature difference in an analogue mode can be used for determining hot water consumption.

6.1. Project activity under a Programme of Activities

33. For a programme of activities, if the model simulation method is used the eligibility criteria for inclusion of a CPA in a PoA shall define the conditions under which the model need to be calibrated (or conditions under which model need not be calibrated for inclusion of a CPA). Where there is a defined need to calibrate the model, it shall be calibrated within the first year of project installation using data (energy use, weather data, water

consumption rate, baseline and project system characteristics, and residence characteristics) collected during the same year that the model is calibrated. The model shall meet the specifications of and be calibrated to the requirements of relevant internally recognized standards/guidelines, e.g. ASHRAE Guideline 14-2002, Measurement of Energy and Demand Savings, Whole Building Calibrated Simulation Performance Path.[13]

[13] American Society of Heating, Ventilating, and Air Conditioning Engineers, Atlanta, Georgia, USA or equivalent guideline.

Appendix. Explanation of choices of methods for emission reductions determination

Table. Choices of Methods for Emission Reductions Determination

System Designation	Large	Small	Very Small
Size of Collector Array per stand-alone system	Any Size	100 m^2	8 m^2
Expected number of installations per project	One or more	Many	Very many
Loads that can be supplied	Residential or commercial	Residential	Residential
CER calculation Methods that can be used	System Metering	System Metering or Model Based Method	System Metering, or Model Based Method, or Stipulated Energy Saving Method

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Document information

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