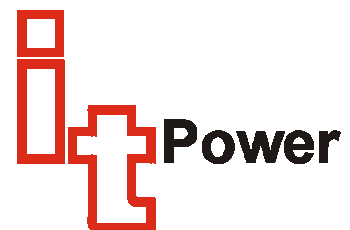
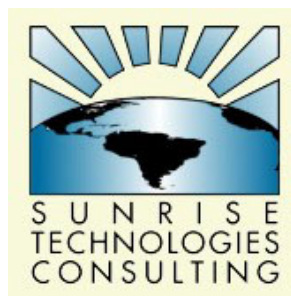
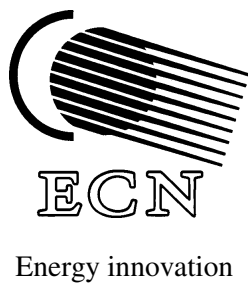


**Guidelines  
for Validation, Monitoring and Verification  
of Solar Home Systems  
under the Clean Development Mechanism**

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## 1. INTRODUCTION

These guidelines have been prepared as part of the study 'Towards a Streamlined CDM approach for solar home systems'. The study was initiated by the Dutch Export Group on PV, financed by the Shell Foundation (Phase II) and Novem, Netherlands Agency for Energy and Environment (Phase I), and executed by ECN, IT Power, and Sunrise Technologies Consulting.

The project's goal is to facilitate the participation of an important category of clean rural energy activity in the carbon offsets markets by advancing procedures that are simple and at the same time environmentally credible. A more detailed description underlying the choices made in this methodology can be found in the discussion paper accompanying these guidelines:

- Martens, J.W., S.L. Kaufman, J. Green, F.N. Nieuwenhout (2001): *Streamlined CDM procedures for Solar Home Systems: A review of issues and options*, ECN-C--01-098<sup>1</sup>.

In absence of clear international guidelines on simplifying procedures for small projects under the CDM, the study has benefited from feedback provided during discussions and interviews with a wide group of stakeholders.

The streamlined guidelines for solar home systems presented in this document are intended to assist project developers in addressing three of the most time consuming items of the project design document:

- a) Baseline methodology
- b) Monitoring plan
- c) Calculations of the net GHG emission reductions of the project.

These guidelines are also intended to help guide the process of updating the standardised global emission reduction formula for solar home systems, which the project team recommends should be done periodically under the direction of the UNFCCC.

### 1.1 Structure of the proposed guidelines

The figure below provides a graphical presentation of the proposed streamlined baseline setting and M&V processes for SHS CERs and indicates how these relate to the various sections of this document.

The CERs of a SHS-CDM project would be calculated on the basis of the formula presented in section 2, providing a fixed value for the total duration of the crediting period.

Sections 3 and 4 address project monitoring and verification respectively. The purpose of monitoring is to determine how many systems are entitled to CERs. Monitoring could be done by individual projects or by an umbrella organisation. Monitoring would involve maintaining a status list of SHSs deployed in the field (section 3.2). The status list will be based on an annual system installation report (section 3.3) and a system performance report (section 3.4).

Section 5 suggests a methodology for updating the standardised emission reduction formula for solar home systems. While this activity falls outside the responsibility of individual SHS-CDM project participants, it is recommended that such updates should be conducted periodically with guidance from the UNFCCC.

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<sup>1</sup> This paper and other relevant background material can be found on:  
[http://www.ecn.nl/unit\\_bs/kyoto/mechanism/cdmshs.html](http://www.ecn.nl/unit_bs/kyoto/mechanism/cdmshs.html)

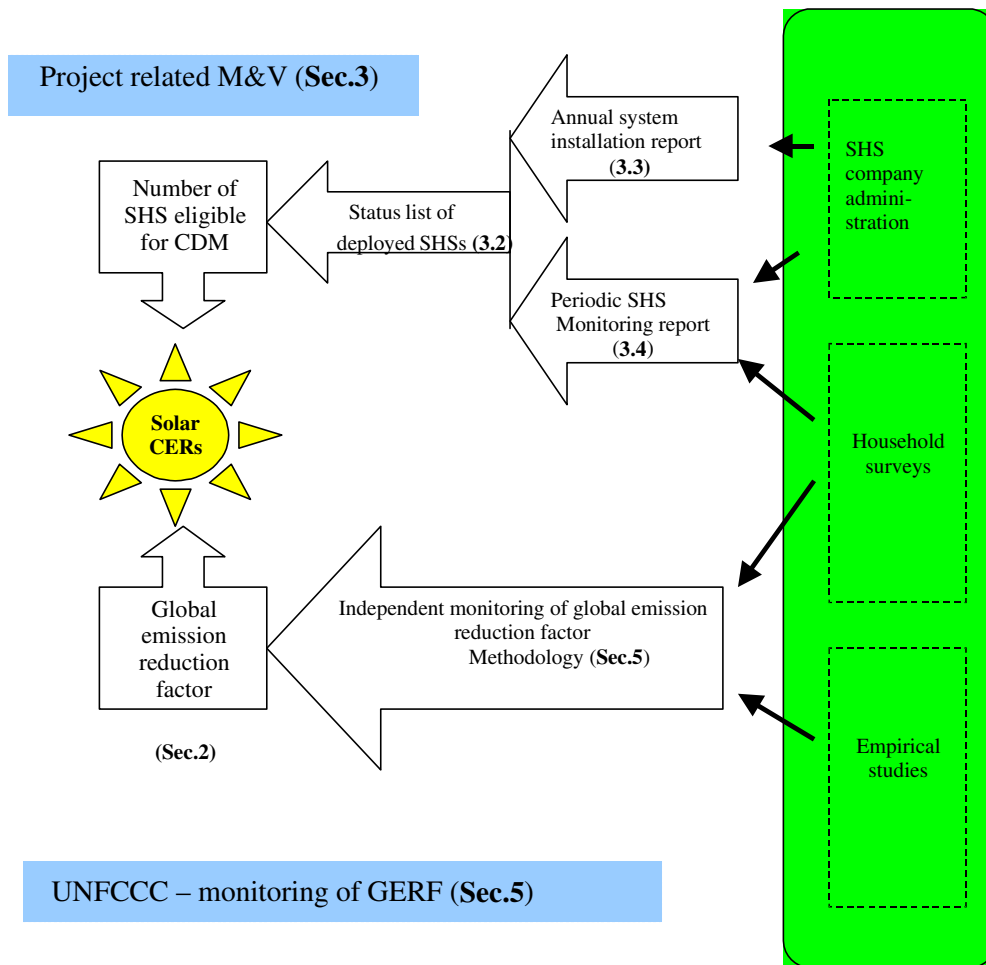


Figure 1.1 *Monitoring procedures for SHS-CDM projects*

## 2. STANDARDISED BASELINE

### 2.1 Global emission reduction factor

As a standardised baseline for solar home systems, project developers may use a global emissions reduction value. The working definition for SHS is an integrated PV system comprised of at least 1 PV module, a battery, wiring, and at least one light. The global SHS emission reduction value is applicable for systems in the size range of 10 to 100Wp.

The Global Emission Reduction Formula for SHS:

- The CO<sub>2</sub> calculation formula for every SHS per year is: 75 kg CO<sub>2</sub> per system plus 4 kg CO<sub>2</sub> per Wp of the module belonging to that system (see figure).

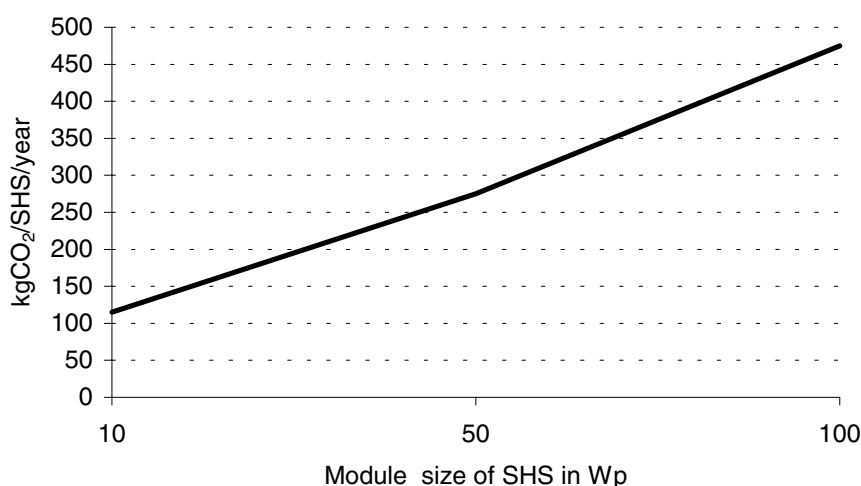


Figure 2.1 CO<sub>2</sub> calculation formula for SHS

The derivation of the global emission reduction formula and an explanation of various baseline scenarios that were considered are detailed in the accompanying discussion paper (i.e., Martens, J.W., S.L. Kaufman, J. Green, F.N. Nieuwenhout (2001): *Streamlined CDM procedures for Solar Home Systems: A review of issues and options*, ECN-C--01-098).

#### Validation

The number of CERs expected to be generated by the project can be estimated on the basis of the above emission reduction formula, the lifetime of systems, the crediting period selected, the lifetime of the project, and an estimate of the annual number of systems newly deployed (i.e., sold or rented to users).<sup>2</sup> The estimated annual number of sales can be deduced from a market study/feasibility study and should be corrected for average expected availability using the figures provided. Expected availability estimates, which depend on the type of business model employed, should assume the following:

- Cash sales - 70%
- Cash sales in combination with a maintenance/service network 85%
- Fee for service 95%

<sup>2</sup> Wherever the terms 'sales' and 'sold' are used in this document, they refer both to systems sold to users and to systems that are newly deployed to users via rental arrangements through fee-for service operations.

### 3. MONITORING PROCEDURES FOR SHS-CDM PROJECTS

CDM requirements for project participation are likely to be perceived by SHS entrepreneurs as complex and technical. A project aggregator or special purpose umbrella organisation could help SHS businesses participate in the CDM. The monitoring plan presented in this Section has been developed with the expectation that it will be implemented by a SHS CDM umbrella organisation functioning as an intermediary between the Operating Entity (OE) and a number of SHS companies in the field. An umbrella organisation could assist in bundling SHS projects, organising the CDM administration and selling solar credits on the international carbon markets (see figure 3.1). Similar procedures could be used for projects implemented by a single company.

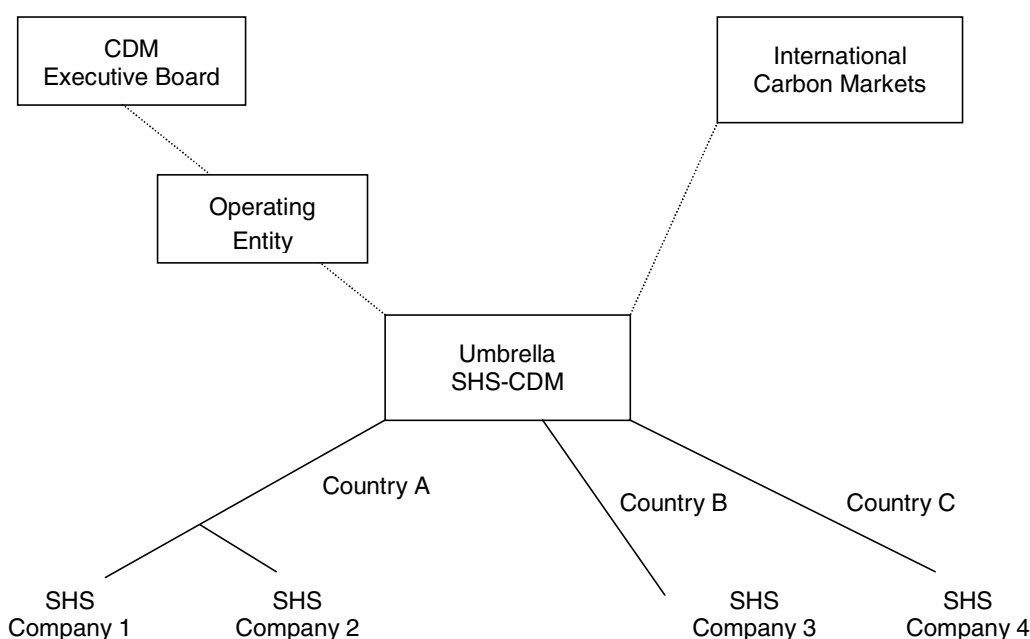


Figure 3.1 Example of the umbrella organisation

The objective of monitoring for the umbrella organisation of a SHS-CDM project is to calculate the CERs for each company it is working with (see Section 3.1). To achieve this, the umbrella organisation will maintain a status list for each company (section 3.2). Each company will inform the umbrella organisation the number of eligible systems it has sold each year through an Annual System Installation Report (section 3.3). To gain CERs, the SHS company must also submit a System Performance Report in which it demonstrates the number of eligible systems reported to the umbrella organisation that are still operating (Section 3.4).

#### 3.1 CER calculation

In order to calculate the amount of CERs, the formulas presented below could be used. The amount of CERs generated by a SHS-CDM project should be determined on the basis of monitoring in year X of SHSs installed in year Y.

- Amount of CERs in t CO<sub>2</sub> per project at monitoring year X:  
*Sum of individual kg CO<sub>2</sub> reduction per SHS/1000*
- Individual CO<sub>2</sub> reduction per SHS in kg CO<sub>2</sub>/SHS:

$$(75 \text{ kg CO}_2 + 4 \text{ kg CO}_2 \text{ Wp}_{\text{SHS panel size}}) * \text{Uncredited operating time of SHS in years}$$

- Uncredited Operating Time SHS (in years) for first monitoring:  
 $((X*12 + \text{month of monitoring}^3) - (Y*12 + \text{month of installation}))/12.$
- Uncredited Operating Time SHS (in years) for second and further monitoring:  
 $((X*12 + \text{month of monitoring}) - (\text{year of previous monitoring} * 12 + \text{month of previous monitoring}))/12.$
- Credit life time expiration. The outcome of the following formula should not exceed 10 years, or else the system will not qualify<sup>4</sup>:  
 $((X*12 + \text{month of monitoring}) - (Y*12 + \text{month of installation}))/12.$

Information for this calculation can be found in the Status List of the SHS CDM umbrella organisation.

### 3.2 Status list of SHS CDM umbrella organisation

To calculate the amount of CERs using the above methodology, the SHS CDM umbrella organisation should keep a status list of all eligible SHSs in its records.

The information in the status list will be compiled from two separate monitoring reports:

- the annual system installation report,
- the periodic system performance report.

The status list contains the status of SHSs reported under the project, each of which is identified with a unique SHS-CDM identification number. For each system, the status list will include:

- country where system is installed,
- SHS company identification number,
- PV panel manufacturer,
- system size,
- year and month of installation,
- year and month of each monitoring report.

### 3.3 Annual system installation report

Each SHS will be able to generate CERs upon installation. When a SHS is installed, it will be reported through an annual system installation report. The annual system installation report will be issued per SHS company. It will provide the information necessary for CER calculations as well as that required to verify that the SHSs have actually been sold.

The annual system installation report for each SHS company will consist of the following information:

1. SHS company identification number (assigned by umbrella organisation)
2. Summary list of eligible SHSs installed in that year, each with the following information:
  - SHS credit identification number (assigned by umbrella organisation),
  - serial number of PV panel(s) included in SHS,
  - country where system is installed,
  - SHS company identification number,
  - PV panel manufacturer(s),

<sup>3</sup> Fill in the number of the month, i.e. January = 1, February = 2, ..., December = 12

<sup>4</sup> The 10-year period figure assumes that a 10-year credit period has been selected for CDM participation. If the 7-year CDM credit period option is used, the outcome of the formula should not exceed 7 years. Credits generated for other carbon markets may substitute other applicable credit periods.

- system size,
  - guarantee period of the PV panel(s).
3. SHS credit registration form
- system description,
  - panel manufacturer and serial number(s),
  - details of SHS company's administration where the following items can be found and verified:
    - purchase declarations of PV panel and BOS components
    - sales receipts of customer
    - other relevant information.
  - attachment including individual sales forms of customers including their name, address, signature and (for a designated percentage or number of customers) questionnaires on baseline emissions.
4. Accountant declarations
- statement of financial auditor/accountant that the SHS credit registration form and the underlying documents of the administration have been verified by him/her,
  - statement of PV panel supplier that the PV panels with the listed serial numbers have been supplied to the SHS company.

### 3.4 Periodic system performance report

A periodic system performance report will be issued per SHS company and will show what percentage of the systems are still operating and thus eligible for crediting of CO<sub>2</sub> reductions.

The periodic system performance report for each SHS company will consist of the following information:

- list of all SHSs for which the monitoring results will apply, identified by SHS credit identification number, country where system is installed, and SHS company identification number,
- year and month of each system performance report,
- monitoring methodology used. The methodology and the sample size of SHS analysed is company specific and depends on the monitoring administration available to the company,
- technical report of the analysis showing how many systems were operating and available to the users,
- conclusion on system availability.

There are two options for monitoring system performance:

1. The first option is that SHS companies could organise and conduct system performance monitoring themselves. This option might be particularly efficient for SHS companies that have service contracts with their customers and thus already have a system for performance monitoring. This is especially likely for companies operating under fee-for-service or that provide credit to their customers. Companies with such arrangements can use revenue records from system rentals or loan payments to indicate system availability. Credit or revenue records need to be transparent, consistent, and available to a third party verifier.
2. The second alternative is to have an independent third party implement the monitoring of system availability. In this approach, by hiring independent experts and involving the Operating Entity in the monitoring process, monitoring and verification efforts will be combined. Thus the costs of verifying by means of a household survey could be avoided.



## 4. VERIFICATION

Verification will be done by the designated Operating Entity. The following will be the subject of verification activities:

- CER calculation and status list
- annual installation reports of the relevant SHSs,
- periodic system performance reports.

### 4.1 Verification of annual installation report

Much of the information required to ensure that systems have indeed been sold is already checked by financial auditors who verify companies' accounts. Companies that have regular accounting audits thus have the basis for verifying SHS sales for CDM purposes. With little extra action, this existing system can be used for CDM verification. An independent auditor/accountant used by the SHS company could thus verify the annual system installation report and issue a separate statement to the umbrella organisation that the systems have been sold. The umbrella organisation will then submit this document to the OE who can validate its authenticity with the respective auditor.

To avoid double counting and facilitate verification, the umbrella organisation should keep a central electronic database for PV modules registered for SHS applications in the CDM. The database will record the name of the module manufacturer and the unique serial number of each registered module based on a specified format for each manufacturer. The Operating Entity can double-check the registration numbers with the accountant statements of PV manufacturers.

### 4.2 Verification of system performance report

Where monitoring is conducted independently by SHS businesses on the basis of performance records for their SHSs, verification could be implemented through verifying the service contract records of the involved companies. Similar to the process with the Annual System Installation Report, an independent local auditor/accountant could verify these records.

Where an independent third party does the system performance monitoring, the Operating Entity should be engaged early in the process. By executing the monitoring according to its standards, the tasks of the Operating Entity could be limited to reviewing the country surveys and subsequent monitoring reports.

## 5. UPDATE OF THE GLOBAL EMISSION REDUCTION FIGURE

*[This Section is meant as guidance for the Executive Board and not for the Project Design Document of individual CDM projects]*

The global standardised emission reduction factor used in the standardised CER calculation formula has been established from a limited number of case studies. As such it is not a scientifically rigorous figure, but it is the best available estimate. Using the global emission reduction factor (GERF) can help to initiate SHS participation in the CDM. Once projects get going under the CDM, monitoring can provide the basis for an improved global emission reduction factor. An important element of the philosophy behind this approach is to collect data to update the GERF under guidance of the CDM Executive Board or other responsible entity in the UNFCCC.

### 5.1 The global monitoring approach.

It is proposed that an independent team of researchers conduct household surveys to gather the information on fuel savings in order to periodically update the global SHS emission reduction value. This systematic monitoring should be co-ordinated at the global level in a transparent way that it is acceptable to the CDM Executive Board. To fund the global monitoring and periodic updating of emission reduction values, a fixed amount of CER revenues (for instance 5%) from every SHS-CDM project participating in the streamlined methodology could be set aside, or else funding could be provided from other sources such as official development assistance (ODA), the GEF, and/or private philanthropy. The global monitoring approach will enable transaction costs to be minimised as monitoring and verification efforts are combined.

The proposed baseline methodology is based on fixed baseline principle. If a new value for the GERF becomes available, it will apply for new SHS-CDM installations submitted for certification after the update of the value, not for installations deployed before the update.

### 5.2 Practical guidance for monitoring of the GERF

The monitoring methodology will involve tracking a sampling of systems to gather information on relevant fuel use before and after SHS installations. To collect information on fuel savings that can be correlated with system size, the project team suggests a two-step process: 1) baseline data retrieval and 2) follow up household surveys.

#### 1. Baseline data retrieval

At the time when SHSs are deployed (i.e., sold or rented to households), the SHS companies would be instructed to ask a sampling of their customers to fill out questionnaires with baseline information:

- system size and characteristics (done by sales company),
- household information on monthly fuel consumption and expenses for kerosene, number of kerosene wick lamps, candle use, and battery charging,
- biographical information: profession, income, family size, etc.,
- intended use of SHSs: TV, radio or lighting. How many rooms to be lighted.

## 2. Household surveys

Within one year of initial system deployment, the monitoring team will organise and conduct surveys of a random sample of SHS households, stratified by system size; preferably this would be done in collaboration with the companies engaged in SHS-CDM project activities.

The person conducting the survey will question the household (preferably asking the person who pays the bills) about the quantity of kerosene and candles they still use on average per month for lighting and the number of times (if any) they still charge a car battery at a charging station. To get good data points, individual household reports of continued kerosene use will need to be compared with the baseline retrieval information for those same households.

In order to contain costs while achieving reliability, statistical sampling techniques should be employed using the minimum sample size needed to provide a sufficient level of confidence and precision. Preliminary calculations indicate that 5% of CER revenues of SHSs will be enough to sample 1% of the SHSs sold. Costs of such a procedure could be reduced by using local researchers (e.g., from NGOs, universities, public agencies) to the extent possible.