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STREAMLINING CDM PROCEDURES FOR SOLAR HOME SYSTEMS
-
A REVIEW OF ISSUES AND OPTIONS

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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 while at the same time environmentally credible.

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 too numerous to mention individually. Appendix A lists the people who participated in full, structured interviews. We would like to extend our sincere gratitude to all those colleagues who have shared with us their time, insights, and ideas.

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Further information and background on this study can be found at:
http://www.ecn.nl/unit_bs/kyoto/mechanism/cdmshs.html

Abstract

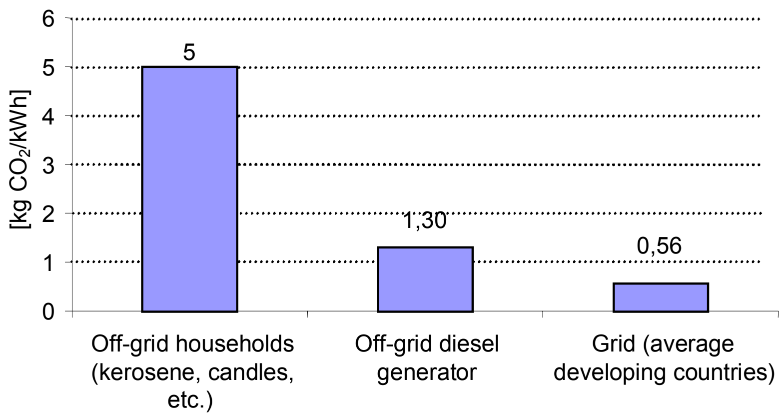
Solar home systems could be an excellent fit for the Clean Development Mechanism under the Kyoto Protocol because they directly displace greenhouse gas emissions while contributing to sustainable rural development. Selling certified emission reduction credits under the CDM could help to accelerate SHS deployment. High transaction costs related to CDM procedures might, however, prevent SHSs from benefiting from the CDM. This report explores how standardised baselines and streamlined monitoring and verification procedures could assist in reducing those transaction costs.

CONTENTS

EXECUTIVE SUMMARY

At Dutch PV Export Group's behest, with funding from Novem and the Shell Foundation, ECN, Sunrise Technologies Consulting, and IT Power completed a 15-month study to develop streamlined processes to facilitate solar home system (SHS) participation in the Clean Development Mechanism (CDM). With input from a wide range of stakeholders, the SHS-CDM streamlining project aimed to develop simple methods for baseline setting, monitoring and verification (M&V), and other CDM-related processes.

Solar home systems use solar energy to generate electricity for individual rural homes that are not connected to an electric grid. They could be an excellent fit for the CDM since they simultaneously displace GHG emissions and contribute to sustainable rural development. The quantity of CO_2 abatement per household is quite small but the rate per kWh is very high in comparison to other applications, as illustrated by the figure below.



(Source: Ybema et al, 2000; Lazarus et al, 2000; Bosi, 2001)

Figure S1.1 *CO_2 reduction potential using different references*

Given the potential complexity of CDM rules and administrative procedures, many analysts have expressed concern that transaction costs could make small project participation very difficult. A study by PriceWaterhouseCoopers, for example, found that transaction costs could amount to a substantial percentage of, or even exceed, Certified Emission Reduction (CER) values for small renewable energy projects. If not specifically addressed, the CDM could miss out on opportunities to advance clean energy applications that support rural development.

To make CDM participation viable for small-scale renewable energy projects, the Bonn Agreement (Decision 5/CP.6) has special provisions, called 'fast-track' procedures, for small projects. The agreement stresses the development and adoption of simplified CDM processes for qualifying projects, including renewable energy projects of up to 15MW, as part of the of the CDM Executive Board's work plan for the coming year. Fast-track procedures will potentially include standardised baselines and streamlined monitoring and verification.

S1.1 Standardizing emission reduction baselines

Standardised baselines have long been seen as a way to make CDM emissions measurements consistent and transparent; they could also be an important measure to help contain CDM-related transaction costs for SHSs and other small-scale activities. To develop a standard baseline methodology for SHSs, the project team considered: what would constitute an appropriate reference scenario for energy use without SHSs; what level of aggregation would be best; and how standard figures could be calculated per SHS installation.

For the baseline reference case, the project team considered traditional domestic (i.e., household) fuels, off-grid generators, and grid extension, and ultimately selected traditional domestic fuels since they most commonly supply energy in the absence of SHS installations. Traditional domestic fuels include kerosene for lighting and car batteries, charged with grid electricity or generators, for small appliances. These have almost always been used as the baseline for Global Environment Facility and Activities Implemented Jointly SHS projects.

Regarding the level of aggregation, while project baselines and possibly country or regional baselines could provide greater accuracy at a higher cost, the team selected the global level as a starting point for SHS baseline standardisation. Eight case studies of SHS installations in Africa, Asia, and Latin America found that carbon abatement varies within and between countries. While that analysis provides a basis for estimating global average CO_2 abatement, considerably more data would be needed to calculate standard baselines or abatement values at the country or regional level. A global standard value could help to initiate SHS-CDM projects and thus provide the basis for better data to improve global values or shift to regional or country ones over time.

Based on data from eight case studies, the team found that roughly 250kg CO_2 per average SHS (of 44Wp) per year would represent a conservative global value. The figure below depicts annual CO_2 reductions per SHS versus cumulative SHS installations in the countries studied; the 250kg value is considered conservative since 70% of emission reductions were estimated to be higher.

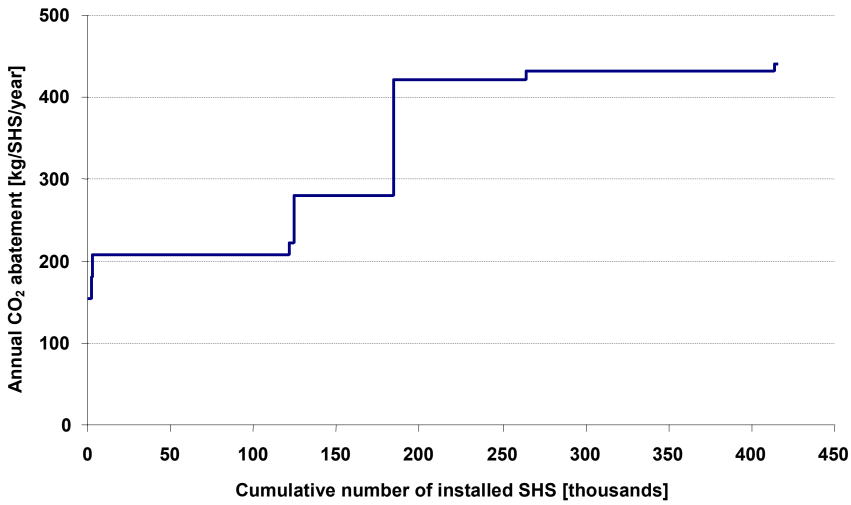


Figure S1.2 C*umulative CO_2 reductions of SHSs in analysed case studies*

To establish a SHS carbon abatement formula, the project team considered using parameters per kWh, Wp, and system, and ultimately selected a hybrid approach applying a reduction value per system and Wp. Though quite limited, the available evidence seems to suggest that introducing a SHS of any size will reduce household lighting fuel use, yet system size is also an important parameter. This notion has been incorporated into our proposal for an annual CO_2 reduction calculation formula: 75 kg CO_2 per SHS plus 4 kg CO_2 per Wp.

S1.2 Streamlining monitoring and verification procedures

Since SHS installations are often widely disbursed in sparsely populated and difficult to reach areas, M&V costs could make CDM participation prohibitive if each household with a system is visited. Simple and efficient procedures are clearly required. There are three variables that need to be monitored and verified in order to correctly establish emission reductions from SHSs:

- number of systems deployed (sold or rented),
- number of systems operational in the field,
- estimated fuel savings per available system.

Since we propose using standardised baselines, while system deployment and operations would be monitoring at the project level, estimated fuel savings would be determined globally and reflected in the standard value.

The most obvious way to streamline project-level monitoring processes would be to make use of existing documents and procedures. Discussions with SHS companies revealed that most SHS companies have their administrative records checked by local accountants or auditors, including data most relevant to verifying systems sales and installations. With little extra action, these existing records can be used for CDM verification.

Some SHS companies provide service contracts to their customers and keep maintenance records for their systems. Information from such maintenance records could be used to monitor the number of systems operating in the field. If such maintenance records are not available, surveys of a sampling of households would be required. Their costs could be minimised if monitoring and verification could be combined, enabling a single trip to be made.

Under a standardised baseline regime, monitoring of domestic fuel savings could be done by the UNFCCC. This would provide the basis needed to update and increase the accuracy of the standard baselines. To reduce costs, an independent research team comprised of local researchers (where possible) could conduct random sample surveys of SHS-using homes. Certain information about kerosene and other fuel use before SHS installations could be retrieved via baseline questionnaires from a sample of customers during the installation of their systems.

S1.3 Other measures to facilitate CDM participation

During the study, the project team considered and discussed with stakeholders other measures that could potentially facilitate CDM participation for SHS activities. Categorical project eligibility, for example, without the need to determine ‘additionality’ for each individual project, would reduce transaction costs and ease participation without a significant risk to the global environment. Project aggregation, possibly facilitated by a special entity dedicated to coordinating small-scale renewable energy CDM project participation, could spread fixed transaction costs over a number of small or medium sized projects.

S1.4 Cost impacts of streamlining

Cost projections generated by the project team indicate that the proposed streamlining measures could have a significant beneficial impact. They could cut overall transaction costs in half and reduce project development costs to a third of what they otherwise might be. Still, the transaction costs analysis indicates that SHS projects must be quite large-scale or aggregated to cover transaction costs. Furthermore, a minimum CER price of around US$ 10 per ton CO_2 may be needed to make SHS CDM participation worthwhile. Over time, as experience is gained implementing the CDM procedures, transaction costs will likely go down, enabling more SHS projects to enter the CDM and to derive greater value from participation.

S1.5 Recommendations

Supported by feedback from a wide range of stakeholders, it is recommended to include a standardised baseline for solar home systems in the CDM guidelines based on a global emissions reduction value. The proposed annual CO_2 abatement formula, applicable for every SHS of 10 Wp to 100 Wp., is: 75 kg CO_2 per system plus 4 kg CO_2 per Wp.

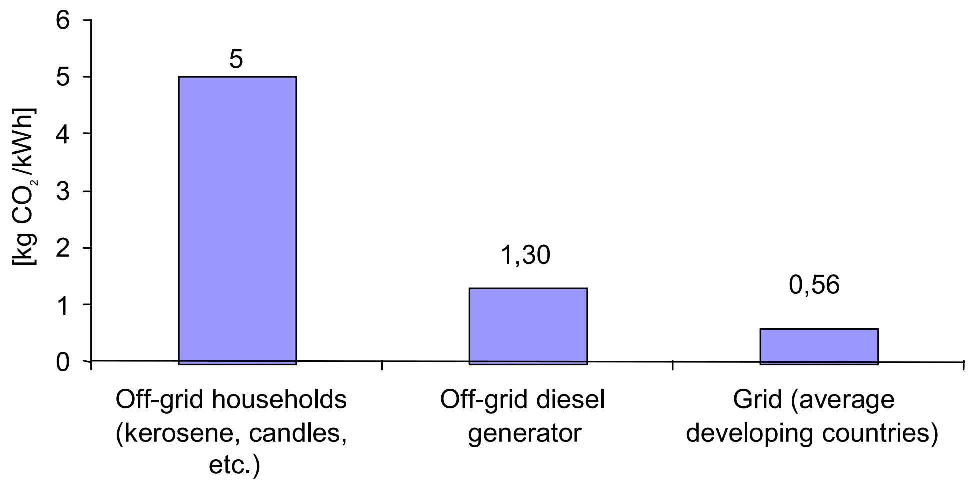
It is also recommended that SHS projects base M&V procedures on existing documents and financial auditing procedures to the extent possible.

1. BACKGROUND AND INTRODUCTION

The Clean Development Mechanism (CDM) is an instrument established by the Kyoto Protocol to achieve sustainable development and contribute to the cost-effective mitigation of climate change. The CDM will allow countries with emission reduction commitments (Annex I countries) to meet part of their reductions abroad where greenhouse gas (GHG) abatement costs can be lower. The CDM will also enable developing countries to attract investments in clean energy technology and assist them in reaching a sustainable development path.

Given the current design of the modalities and guidelines and the competitive nature of the CDM, high transactions costs and low per-installation carbon abatement could make it quite difficult for off-grid renewable energy projects to derive value from participating in the CDM. If not specifically addressed, the current CDM regulations would mostly favour large-scale urban and industrial projects and leave out opportunities for promoting clean rural development. This would be very unfortunate, since off-grid renewable energy projects rank high in terms of fostering sustainable development as well as offering a safe and long-term solution for climate change.

Solar home systems (SHSs) use solar energy to generate electricity for individual rural homes that are not connected to an electric grid. They are a small-scale activity that can be an excellent fit for the CDM because they directly displace GHG emissions while contributing to sustainable rural development. While the quantity of carbon dioxide (CO_2) emissions abatement is quite small per household, the rate of displacement per kWh in off-grid household applications is very high, as illustrated in Figure 1.1 below.



(Source: Ybema et. al., 2000; Lazarus et. al. 2000 ; Bosi, 2001)

Figure 1.1 *CO_2 reduction potential using different references*

1.1 Streamlining CDM procedures for solar home systems

Over a 15-month period ECN, Sunrise Technologies Consulting, and IT Power conducted a two-phase project to streamline CDM procedures for solar home systems. The project's first phase is documented in Ybema et al., 2000 and summarized below. The remainder of this report documents the findings and recommendations from the project's second phase.

1.1.1 Main results of Phase I

In Phase I (see Ybema et al., 2000), the project team gathered and analysed information from SHS case studies in order to estimate the associated emission reductions. Case studies were selected from the following eight countries:

- Argentina
- Honduras
- India
- Indonesia
- Kenya
- Nepal
- South Africa
- Swaziland.

The case studies show a significant range in emission reductions from SHS installations within and between countries. This wide range in emission reductions indicates that the use of national customised emission reduction values would not necessarily be more accurate overall than a global emission reduction figure. Thoroughly studying emissions abatement in each country would be time consuming and expensive. Transaction costs for CDM participation would be substantially lower using global emission reduction figures.

As a result of Phase I, the study team suggested the initial adoption of a global emission reduction value to facilitate SHS participation in the CDM. The team selected an emission reduction value instead of a baseline emission value because the reduction value is most often what is reported in surveys of SHS-using households. The uncertainly in estimating standard SHS baselines and standard SHS emission reduction values is probably about equal. Using standard baseline values, however, would necessitate substantial additional project-level monitoring to quantify emission reductions without increasing the accuracy of the emission reduction calculations. SHS CDM projects could thus begin with global emission reduction values. Then, once more information becomes available, customised elements could gradually be introduced or else the global emission reduction figures could be periodically updated.

The Phase I study also concluded that SHS projects usually have a strong case with respect to additionality based on the existence of specific barriers, which limit the development of the rural, off-grid SHS market. These barriers include lack of consumer financing available to ease the burden of high upfront photovoltaic (PV) system costs, lack of available PV products and qualified service technicians in rural areas, low awareness about SHSs among those without systems, and the need for improved management skills within the businesses participating in the SHS marketplace. These barriers are often compounded by market distortions caused by subsidies for grid-electricity and conventional fuels as well as high import taxes on PV modules.

Given projected Certified Emission Reduction (CER) prices, CDM participation can potentially boost SHS dissemination, but only if transactions costs are sufficiently low. The potentially high fixed costs for CDM participation could make it difficult for all but the largest SHS projects to participate.

1.1.2 Phase II

Streamlining CDM procedures is not limited to the development and use of standardised baselines. In order to promote SHS activities under the CDM, barriers at every step of the project cycle must be addressed. The objective of Phase II of the project is to further develop CDM procedures and suggest institutional structures to minimise transaction costs, receive stakeholder feedback on the developed methodologies and adjust them where appropriate, and raise awareness among the relevant prospective users of these guidelines. The final step is to submit guidelines into the UNFCCC process for fast-tracking small CDM activities.

The project team has identified several interrelated issues that could have important ramifications for streamlining CDM procedures for SHSs. The issues relate to CDM eligibility (i.e., additionality), baseline setting, and monitoring and verification. Some are quite technical in nature while others are more general and policy-oriented.

An important objective of Phase II was to gain broad consensus on the developed methodology. This was addressed by gaining viewpoints from many individuals and undertaking in-depth interviews with about 30 experts and stakeholders (see Appendix A). These stakeholders represented several perspectives on the subject including:

PV Industry perspective
- PV manufacturers
- Project developers
- Industry consultants.

Development perspective
- Host countries
- International donors
- Non-governmental organizations (NGOs)
- Research institutions
- Multilateral development banks.

Baseline /MERV Perspective:
- Auditors
- Academics
- NGOs.

Investor perspective:
- Bilateral investors (Annex I Parties)
- Multi-lateral investors
- Private investors
- Intermediaries.

This report discusses the major issues related to streamlining CDM procedures for SHS and presents the findings of Phase II. While the analysis and recommendations in this report focus on solar home systems, such systems are just one of many clean energy technology applications that could contribute to climate protection and sustainable development through the Clean Development Mechanism. The general analytic approach outlined in this report as well as some of the specific findings should be applicable to other small-scale renewable energy technologies.

1.2 CDM project cycle

The first step in the CDM project cycle would be to prepare a project design document detailing project eligibility/additionality, baseline reference case selection and quantification, and monitoring and verification plans. The major components of the project design document include (UNFCCC, 2002[1]):

a) a description of the project,
b) proposed baseline methodology,
c) statement of the estimated operational lifetime of the project,
d) description of the additionality of the project,
e) environmental impacts of the project,

[1] See Marrakesh Accords, draft decision -/CMP.1 (article 12), Appendix B.

f) information on sources of public funding from the involved Annex I Parties,
g) stakeholders comments received on the project,
h) monitoring plan,
i) calculations of the net GHG emission reductions of the project,
j) references to support the above.

The project design document would then be validated and the project registered. Monitoring, verification, and emission reduction certification would follow. The CDM processes may involve several entities and review times could be lengthy. Furthermore, eligibility rules may be complicated, which may reduce the certainty regarding project eligibility for individual project owners.

Figure 1.2 shows the major steps in the CDM project cycle and indicates the party that would be responsible for implementing each step.

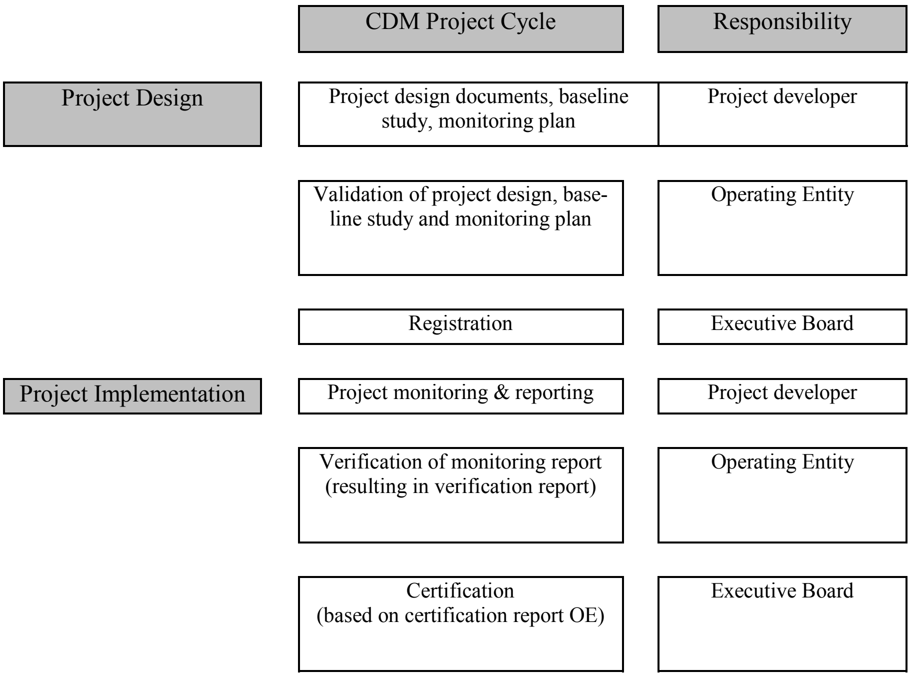


Figure 1.2 *CDM project cycle*

Given the number and potential complexity of rules and administrative procedures being proposed for the CDM, many observers have expressed concern that transaction costs could make small project participation very difficult. For example, a study by PriceWaterhouseCoopers (PWC 2000) found that transaction costs could amount to a substantial percentage of, or even exceed, CER values for small renewable energy projects. Other studies have reached similar conclusions. If not specifically addressed, the CDM could mostly favour large-scale urban and industrial projects and leave out opportunities for advancing clean energy for rural development, particularly in least developed countries where off-grid renewable energy applications are likely to be the predominant sustainable option.

To make CDM participation viable for small-scale renewable energy projects, Parties have proposed special provisions, components of which have cycled in and out of the CDM negotiating texts. Following the successful conclusion to negotiations in Bonn and Marrakesh in the latter part of 2001, qualifying small-scale CDM projects will be subject to special treatment as discussed in Section 1.3 below.

Terminology
In the UNFCCC terminology and literature, CDM activities are often referred to as CDM projects. Confusingly, in the SHS literature there are many different references of SHS projects, most of which would not match with what would constitute a SHS-CDM project. For the purpose of clarity, we explain here the different meanings 'project' could have, and the definition we use in this paper.

There are many different modes for distributing SHSs to end-users including market oriented strategies where SHSs are disseminated by commercial companies and public-sector oriented channels in which governments, NGOs, or donors support SHS projects and subsidise or donate SHSs to end-users (for a good overview of SHS dissemination channels see Martinot et al, 2000). Often, all of these activities are referred to as projects. Donor and government supported efforts to stimulate market-oriented strategies for SHS dissemination are also called SHS projects.

Among SHS promoters there is increasing consensus that market-based SHS dissemination strategies, where end-users pay to purchase a SHS or its services, have the highest chances of long-term sustainability. The streamlined procedures presented in this report have been developed with such market-based strategies in mind. Hence the SHS activities targeted under the CDM are assumed to involve SHSs distributed by commercial companies, either through direct cash sales, sales combined with a credit facility for the end-user, or via a fee-for-service operation, in which the company retains ownership of the system while the end-user pays a periodic fee (e.g., monthly) for the services provided by the system.

In the definitions used in this paper, the term '*SHS project'* is avoided. We will use the term *'SHS company'* when we refer to sales/installations of one company or organisation. In order to derive sufficient economies of scale, in many cases the SHS activities of companies will probably need to be bundled under the CDM. The term *'SHS-CDM project'* will refer to the aggregate of SHS sales and fee-for-service installations of the SHS company or companies registered under that project. 'Sales' or 'installations' refer in general to both sales and installations (including fee-for-service installations), unless stated otherwise.

1.3 Simplified procedures in the Bonn Agreement and Marrakesh Accords

The Bonn Agreement of July, 2001 (Decision 5/CP.6) and Marrakesh Accords of November, 2001 (UNFCCC, 2002) stress the development and adoption of simplified CDM modalities and procedures for qualifying small-scale projects as part of the work plan of the newly selected CDM Executive Board. A committee or panel of experts to assist the Executive Board in developing fast track procedures will likely be assembled in 2002.

The agreements specify that qualifying small-scale project activities will be defined as:

- renewable energy project activities with a maximum output capacity equivalent of up to 15 MW,
- energy efficiency improvement project activities which reduce energy consumption by up to the equivalent of 15 GWh per year,
- other project activities that both reduce anthropogenic emissions by sources and directly emit less than 15 kt CO_2 per year.

Apart from standardised baselines, it is generally thought that the simplified procedures to be developed under the Marrakesh Accords could also include streamlined processes for project validation, monitoring, verification, and certification. By taking into account the characteristics of specific industries and project categories, the costs for validation, monitoring, verification, and certification can most likely be reduced greatly, while keeping the credibility of the emission reduction credits at an acceptable level.

In order to produce acceptable procedures that could be applicable to SHS activities under the CDM, it is important to identify the relevant components in the Marrakesh Accords. The relevant components include those areas that deal with the CDM generally and define such processes as validation, monitoring, verification, and operating entities. Most important are those areas that directly relate to the fast-tracking of small projects under the CDM, including standardised baselines and baseline guidelines as well as streamlined procedures for project design documentation, validation, monitoring, verification, and certification.

1.4 Structure of this report

An overview of key issues in fast-tracking SHSs under the CDM is provided in Chapter 2. These include standardising baselines, streamlining monitoring and verification procedures, and other possible items for streamlining. Based on the different elements considered in Chapter 2, Chapter 3 provides an overview of possible options for streamlining CDM procedures for SHSs and includes an analysis of the transaction costs. Chapter 4 provides an overview of the issues involved in organising a SHS-CDM project. Chapter 5 presents a summary of conclusions and recommendations.

2. KEY ISSUES IN FAST-TRACKING SHS IN THE CDM

This chapter reviews the main issues and options related to fast-tracking SHS participation in the CDM. It first introduces each issue and then discusses the options for addressing it based on such considerations as transaction costs, anticipated UNFCCC requirements, and feedback from the people interviewed.

Sections 2.1 and 2.2 discuss how the two items most often mentioned with regard to fast-track procedures, standardised baselines and streamlined monitoring and verification procedures, would apply to SHSs. The next Section, 2.3, discusses further possibilities for fast-tracking SHSs in the CDM.

2.1 Baseline standardisation

Baseline standardisation has long been recognised as an attractive option to make CDM or JI related emissions measurements more cost-effective and transparent, with greater certainty for investors (Lazarus, et al, 1999). These following arguments all apply to SHS projects and provide the rationale for developing standardised baselines:

- *Reducing investor uncertainty* - SHS markets serve poor rural people in less developed counties and are generally perceived as high-risk operations. Risk reduction for SHS businesses is considered an important policy objective to stimulate SHS market development (see for instance ECON, 2000). Given the high level of uncertainty in the market, standardised baselines could stimulate SHS-CDM project development by providing in advance an indication of the CER revenues per SHS.
- *Improving transparency* – Measuring CO_2 reductions is a complex undertaking. While CO_2 reductions are probably best measured through household questionnaires, current practices use a multitude of methods to estimate CO_2 savings, some more reliable than others (see Ybema et al, 2000, for an overview). Standardisation of such measuring practices would relieve SHS companies from a complex task and increase reliability of the available data on GHG reductions from SHSs.
- *Reducing transaction costs* – High transactions costs and low per-installation carbon abatement could make it quite difficult for off-grid renewable energy projects to derive value from participating in the CDM.

2.1.1 Level of aggregation in baseline setting

As mentioned above, standard baselines, and more generally the level of aggregation at which baselines are set, are commonly discussed in relation to streamlining CDM procedures. In addition to affecting the direct cost of baseline setting, the level at which baselines are set will have important implications for project validation, monitoring, and verification.

Options

The project team has reviewed three principal options for baseline aggregation: project baselines, national or regional baselines, and a global abatement value.

- *Project baselines*. This approach, which has been used in Activities Implemented Jointly (AIJ) projects to date, establishes a baseline at the individual project level.
- *National or Regional Baselines.* This approach would set a standard baseline (or carbon abatement value) for all projects in a given category and geographic region.
- *Global Abatement Value*. This option would use a single global carbon abatement value, set conservatively, that could be used by any project in a given category that opts into a highly streamlined methodology for CDM participation.

Benefits and constraints of the options

Project Baselines. Establishing a baseline at the project level can achieve the greatest accuracy but would also have the highest cost. In addition to the cost of establishing the baseline in the first place, project baselines would most likely require individual project validation and more thorough monitoring and verification. Project baselines would probably be most difficult for small-scale SHS dissemination activities and ones relying on user-installed systems, where monitoring would be complicated by the difficulty in locating households.

National or Regional Baselines. Eight case studies carried out by the project team found that carbon abatement from SHS activities varies within and between countries. Considerably more data would be required to calculate standard baselines or carbon abatement values at the country or regional level as compared to the global level. While such an approach would be more expensive, individual projects might not need to bear the cost. Studies funded by host countries, bilaterally, or by multilateral agencies could establish national off-grid household baselines or SHS carbon abatement values to lower CDM transaction costs and ease participation for SHSs. Substantial streamlining would be possible where standard baselines are set at the national level. There seems to be no direct correlation between certain geographic regions (e.g., Southern Africa, South America, South Asia) and SHS carbon abatement by country. While further study may reveal that regional SHS baselines are appropriate in some cases, regional geographic aggregations generally do not appear to be a good distinction for SHS-related baseline setting. The case where this might be most relevant is where a group of small countries share similar characteristics and thus might be able to reduce their transaction costs.

Global Carbon Abatement Value. A standard global abatement value would be simplest, minimizing CDM transaction costs, and may be just as accurate as national values. A single global value or formula might underestimate a share of systems and overestimate another share. But, on a global basis, it could provide a conservative approximation of CO_2 emission abatement per SHS.

Based on the previous analysis in Phase I, it was found that roughly 250kg CO_2 per average system of 44Wp per year would represent a conservative but reasonable global value (derived from Ybema et al., 2000). The analysis applied a consistent carbon abatement calculation methodology (summarized in Appendix B) to data obtained from eight case studies of SHS installations in Africa, Asia, and Latin America. From that analysis, figure 2.1 depicts annual CO_2 abatement in kg per solar home system per year plotted against the cumulative number of systems installed. The analysis indicated that 70% of the estimated emission reductions were actually higher than 250kg CO_2. Hence this quantification, while derived from limited data, could provide the basis for a conservative initial global carbon abatement value.

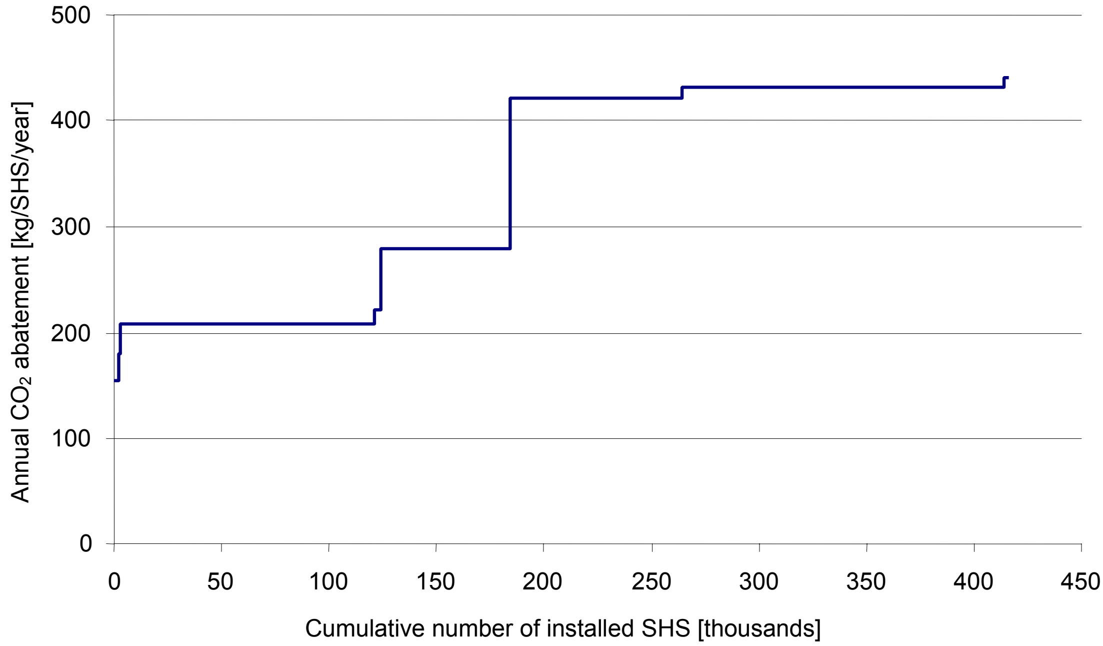


Figure 2.1 *Specific CO_2 emission reductions for eight case studies (source: Ybema et al., 2000)*

An important argument for the global value is the current lack of reliable data. Lack of good baseline data could be a big hurdle for getting SHSs started under the CDM. Without reasonable data there is no basis for a standardised baseline. Without a standardised baseline, there will be fewer or perhaps no SHS CDM projects. Accepting a global baseline for SHS, albeit based on limited data, would provide an opportunity to initiate SHS participation in the CDM. Then, once there are SHS CDM projects, monitoring will provide better data.

A majority of the people interviewed tended to favour a global standard abatement value and expressed that it might be acceptable since the environmental risk associated with inaccuracy is so small. At the same time, however, several people believed that regional or national values would have similar advantages while being more widely accepted.

Recommendation

For CDM participation, the project team proposes to allow SHS activities to use a standardised global emission reduction value. During the execution of the SHS-CDM projects, additional information on emission reductions should be gathered which could serve to improve and gradually introduce customised elements (e.g., national standardised baselines or size specific baselines) into the standardised baselines.

2.1.2 Baseline reference case

The ‘reference case’ is the energy supply scenario used to define the baseline situation for calculating the GHG emissions that would be expected in the absence of SHS installations. Reference case selection will have a big impact on the amount of emission reductions that can be credited to SHS installations. Depending on the reference case selected, the amount of CERs per SHS could vary by a factor of ten. Since the future situation can never be known upfront, there is always a degree of uncertainty in establishing a baseline.

Options
The project team considered three options for baseline reference cases that could be applicable to the energy services supplied by a SHS.

- *Grid-Extension.* In the absence of a solar home system, households in theory could have obtained electricity from an electric grid, if a grid were extended to the household. Thus grid electricity could potentially serve as the baseline reference case for SHS installations.
- *Off-grid Generators.* In the absence of an interconnected grid, some households and groups of households get electricity from diesel generators or small gasoline generators. Diesel mini-grids are a common means of supplying electricity in areas with comparatively concentrated electric loads that are too far from existing grids to make grid extension viable.
- *Domestic Fuel Use.* In this case 'domestic fuel use' refers to the type and amount of fuel consumed by households prior to their SHS installation for energy services that are subsequently supplied by the SHS; generally this is comprised of kerosene lamps and candles for lighting and some amount of battery charging to power televisions in households that subsequently acquire an SHS.

Benefits and constraints of the options
Grid Extension. Solar home systems are not typically installed in areas where grid-extension is likely and do not replace the grid where it already exists. Furthermore, a grid connection baseline would reflect a different level of energy service since such applications as cooking and ironing are not a viable option for SHS. Therefore, a grid baseline is not considered to be a suitable option.

Off-grid Generators. While SHS installations do sometimes replace individual home generators, this is much less common than their replacing kerosene lamps, candles, and car battery charging. Furthermore, SHS installations almost never replace diesel mini-grid systems. In addition, the amount of electric capacity that generators provide to households far exceeds that of typical a SHS. Therefore, generators do not seem the best representation of a SHS baseline.

Domestic Fuels. The domestic fuel option approaches reality most closely since traditional energy use patterns would be expected to continue in the absence of the SHS; thus, the domestic fuel baseline is considered a fairly accurate basis for estimating CO_2 abatement. It has almost always been used as the baseline for Global Environment Facility (GEF) and AIJ projects involving SHSs.

As illustrated earlier in Figure 1.1, with the domestic fuels used prior to SHS installations as the baseline, GHG reductions are expected to be much larger than with other baseline options. This is due to the tremendous inefficiency of kerosene lamps and candles.

In the interviews, experts and stakeholders indicated broad support for a domestic fuel baseline, which was the preferred alternative among 80% of people interviewed and 100% among SHS experts. Generally people view the domestic fuel baseline as most consistent with the accepted idea that a baseline should reflect the situation expected in the absence of the emission-reducing activity.

Some interviewees preferred a baseline of off-grid electrification via diesel generators, based on two different arguments. First, some experts thought that the level of service would be more comparable to that of an SHS, at least with regard to lighting, which they believed to be an important consideration. Also, diesel mini-grids are commonly used to electrify areas that are beyond the reach of electricity grids across the developing world and thus offer a consistent and uniform baseline option that could be applied on a kWh basis.

Recommendation
Since it is most likely to represent the expected energy situation in the absence of SHSs, the project team prefers the domestic fuel baseline. As an alternative, however, a diesel baseline could be appropriate in certain circumstances. For example, where a country has expressly committed to 100% rural electrification, a diesel baseline might be considered a more appropriate option.

2.1.3 System definition

The issue of 'system definition' refers to how a SHS would be defined for purposes of CDM participation.

Options for system definition
A solar home system can be defined either as an integrated system, sold or rented as a unit made up of a PV module, a battery, wiring, lights, etc., or as the compilation of its component parts. The distinction has implications for the types of SHS dissemination that qualify for CERs under streamlined methodologies as well as for monitoring and verification. While many SHSs are sold or rented as complete units, many others are assembled by end-users from components they purchase separately. For example, in some African markets, people commonly purchase a lighting kit (including a PV module with 2 or 3 lights) from one supplier and purchase a battery somewhere else. Alternatively, some people purchase only a module and connect it to a battery they already own.

Options for system definition:
- *PV modules sold to households*. Under this definition, PV modules sold to households would qualify for CERs as an SHS.
- *Integrated SHSs.* Under this definition, integrated PV systems comprised of a PV module, battery, wiring, and at least 1 light would qualify for CERs.

Benefits and constraints of the proposed options
The integrated system definition has the following advantages:
- An integrated system definition would safeguard against mistakenly crediting as an SHS some PV modules used for purposes other than lighting and domestic applications (e.g., for telecommunications or water pumping, which may have a lower baseline than SHS applications).
- In cases where SHSs are deployed to households via fee-for-service businesses and dealer-installed system sales operations, an integrated system definition could be a fairly simple to adhere to, and might pose very little added administrative burden.

The biggest problem with an integrated system definition would relate to module sales to household that integrate their own system, where an integrated system definition would probably be an insurmountable barrier to CDM participation.

The biggest advantage of the PV module definition is that module sales to households would be eligible to receive CERs. Since most (perhaps nearly all) PV modules sold to individual rural households are used for lighting and entertainment (e.g., TV and radio), an integrated system definition would probably be unnecessarily restrictive, excluding the entire SHS market segment comprised of modules and PV lighting kits sold to households that integrate their own system.

The biggest problem with the PV module definition, however, is that the possibility for streamlining monitoring and verification procedures becomes much more complex (see Section 2.2). The additional complexity of possible monitoring and verification rules leads us to suggest the use of an integrated system definition, at least initially.

The interviewees provided limited feedback on the technical issue of system definition, but one person pointed out that an integrated system definition would exclude all add-on modules from CER generation.

Proposed system definition

- *Integrated SHSs.* Under this definition, integrated PV systems comprised of a PV module, battery, wiring, and at least 1 light would qualify for CERs as an SHS.

2.1.4 Credits in relation to system size

An important question regarding SHS participation in the CDM is whether CERs should be credited on a kWh, Wp, or system basis. There is general consensus among SHS stakeholders that kWhs are not a good measure for standardisation as this is difficult to measure, the relation between generated kWhs and used energy services is complex due to losses in the battery, and kWhs are generally not monitored. The project team therefore considered crediting per system and crediting per Wp.

The available empirical data to determine the best option are limited. One study based on household surveys in Kenya shows an increase in CO_2 savings with increasing system sizes. In Figure 2.2 below, this relationship appears fairly linear, but the increase in CO_2 savings is not directly proportional to module size.

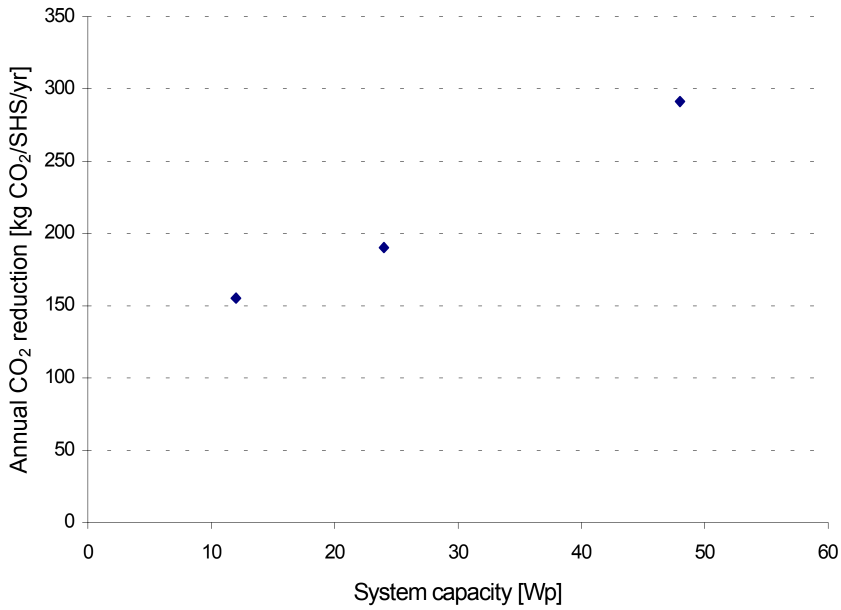


Figure 2.2 *CO_2 reductions from SHSs in Kenya using different numbers of amorphous silicon modules (adapted from Van de Plas and Hankins, 1998)*

Options for unit of standardisation

The project team reviewed three options for crediting systems with CERs in relation to their size.

Option 1: Fixed linear relationship between module size and CO_2 abatement. Since little evidence currently exists to demonstrate the relationship between system size and CO_2 savings, CO_2 savings per Wp may be a reasonable option. Such a relationship could be based on revised figures from Phase I of the SHS-CDM streamlining project. For example, taking an estimated 250 kg CO_2 reduction for on average 44 Wp system per year as a reference point, this would mean 5.7 kg CO_2/Wp/year (figures based on Phase I study results).

Option 2: Two Size Categories. A proportionally linear relation between CO_2 and Wp, however, does not recognise the relatively higher impact smaller systems may have. Hence, a simple distinction could be made between two size categories, big and small.

	System size	CO_2 reduction
Small	12 – 24 Wp	100 kgCO_2/SHS/y
Big	24 – 100 Wp	200 kgCO_2/SHS/y

Option 3: Option 3 is a hybrid option combining elements of option 1 and 2. It assumes that the mere introduction of a SHS in a household will have an impact on kerosene savings, but it also recognises a somewhat linear relation to system size. A proposal could be: 75 kg CO_2 for every SHS plus 4 kg CO_2 per Wp.

Benefits and constraints of the proposed options

From the Kenya data, it appears that carbon abatement will vary by system size, though not in direct proportion to module capacity. It seems logical that, as systems increase in size, the ratio of displaced lighting to the provision of additional energy services would decrease (i.e., less displaced kerosene lighting and greater provision of additional services); therefore, since the greatest CO_2 benefits are derived from displaced kerosene lighting, there should be proportionality less CO_2 displacement per Wp as systems increase in size.

Many interviewees did not comment on the issue, but most who did preferred the option that would make CERs proportional to module size on the basis of kg CO_2 per Wp (option 1). Interviewees supporting that option put forward the following arguments:

- Given the limited empirical evidence this option would be the most straightforward and practical;
- Some experts familiar with the SHS market expressed little confidence in the accuracy of the reported figures from Kenya since in their experience smaller systems in Kenya are used mostly for TV rather than lighting[2].

As smaller systems would likely displace comparatively more CO_2 per Wp, linear crediting under option 1 would be unfair to smaller systems. One interviewee suggested basing credit on the number of lights per SHS rather than Wp; another suggested having a higher abatement value per Wp for the first 25 Wp, and a smaller one thereafter. Some believed that the mere introduction of a SHS into a household has a considerable impact on the energy saved apart from the fact of how many lights are used. Bigger systems might also just use higher wattage lights and not necessarily replacing more kerosene lamps.

Proposed option

Although the empirical evidence to support option three is quite limited, it appears that small systems do abate relatively more kerosene. Where a SHS is sold as an integrated system including at least one light, the chance that it is merely used for television would be minimal. Hence, the project team suggests that option three be used as the formula for calculating CO_2 savings per SHS. Given that little empirical evidence currently exists to correlate carbon abatement with system size, the activities used to monitor the global value should explicitly gather data that can be used to better understand the relationship.

[2] Another disadvantage of providing proportionally more credits for smaller systems than for large ones is that it may induce fraud. A company selling a system based on a 50Wp panel might rather sell the system with 4*12Wp panels and claim more credits for it. However, we believe that if the monitoring and verification procedures of Section 2.2 are properly applied and the integrated system definition is chosen (see Section 2.1.3), this problem will be avoided and small systems could be given proportionally more credits.

2.1.5 Recommendation

Supported by feedback from a wide range of stakeholders, it is recommended to include a standardised baseline for solar home systems in the CDM guidelines based on a global emissions reduction value. The working definition for SHS is an integrated photovoltaic system comprised of a PV module, battery, wiring, and at least 1 light. The formula would apply to solar home systems in the range of 10 to 100 Wp[3]. The proposed CO_2 calculation formula for every applicable SHS per year would be: 75 kg CO_2 per system plus 4 kg CO_2 per Wp (see figure 2.3).

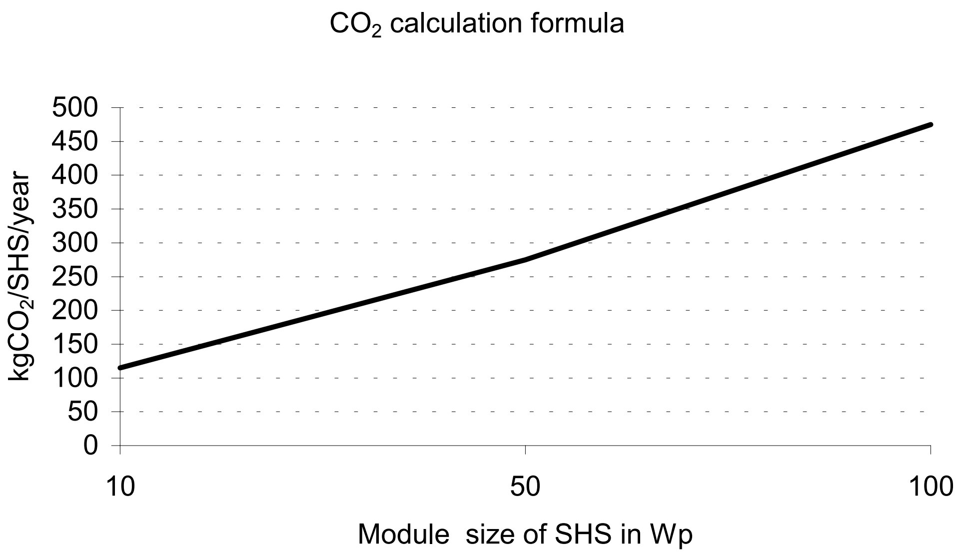


Figure 2.3 *CO_2 emission reduction calculation formula*

2.2 Streamlining monitoring and verification

Since SHS installations are often widely disbursed in sparsely populated and difficult to reach areas, monitoring and verification (M&V) costs could make CDM participation prohibitive if procedures are not sufficiently simple and efficient. Feedback from interviews indicates overwhelming support for streamlined monitoring and verification procedures. There are three variables that need to be monitored and verified in order to correctly establish emission reductions from SHSs:

- Number of systems deployed (sold or rented)
- Percentage of deployed systems available (i.e., operational)
- Estimated fuel savings per available system

The CERs of a SHS-CDM project are calculated on the basis of the formula from Section 2.1.5, providing a fixed value for the total duration of the project. The purpose of project related monitoring is to determine how many systems are entitled to CERs based on the number of systems that have been deployed and that remain available. Section 2.2.1 explains the monitoring and reporting of system deployment. Section 2.2.2 discusses the monitoring of system availability.

The project team recommends that the global emission reduction factor underlying the standard abatement value formula be periodically updated by independent monitoring of kerosene savings, under guidance of the UNFCCC. This is further explained in Section 2.2.3. The new

[3] The proposed formula is intended for fixed SHS systems rather than portable lighting systems (i.e., not solar lanterns) since the carbon abatement characteristics may be different.

abatement value formula will apply for new SHS installations after the formula is updated, but not to SHSs deployed before the update.

The following Sections propose streamlined procedures for monitoring and verification for each of these variables. The benefits and constraints of each proposed procedure are judged on three main criteria: transaction costs, simplicity, and credibility.

2.2.1 Reporting of systems deployed

A distinguishing feature of a SHS is that it is a stand-alone device generating a small amount of electricity for a single household. This feature is the reason why SHSs are attractive for remote households, but it directly complicates monitoring. The most secure approach to monitoring and verification would be to conduct a field audit of every system sold. Such audits have been done by solar home system projects funded by the World Bank and GEF. In the context of the CDM, however, this would be prohibitively expensive. To keep costs down, it is assumed that streamlined procedures should try to minimize field trips for all components of monitoring and verification and especially for monitoring the number of systems deployed.

In monitoring sales at the company level, it will be necessary to ensure that the following three categories of fraudulently claimed emission reduction credits for SHSs are avoided:
1. Credits claimed for systems that have never been sold
2. Credits claimed twice for the same system
3. Credits claimed for PV panels that have not been used as SHS, but for another application.

Proposed monitoring procedure

The most obvious way to streamline the monitoring process would be to make use of existing documents and procedures. Discussions with SHS companies revealed that most SHS companies have their administrative records checked by local accountants or auditors. In a normal audit of a SHS sales company, the auditor/accountant examines the company's revenue from sales based on such documents as their customer invoices, product manufacturers' invoices, etc. Thus companies that have regular accounting audits already have the basis for verifying SHSs sales for CDM purposes. With little extra action, this existing system can be used for CDM verification. The objective is to copy the relevant data for CDM verification into one document, signed by the auditor/accountant of the SHS company, stating that the claimed systems have indeed been sold.

The CDM system deployment report would consist of the following information[4]:
- System description
- Panel manufacturer and serial number
- BOS manufacturers and available serial numbers
- Other information relevant to distinguishing the SHSs, such as sales identification numbers, product numbers
- Name and address of customer
- Signature of customer.

This model would in principle apply for all SHS sales on a cash or credit basis and, with slight modifications, could be used in fee-for service operations. In the case of fee-for-service operations, the verification protocol could be modified to link selected deployed assets (i.e., systems) or rental revenues to specific CDM-registered systems.

[4] For a detailed overview of the involved procedures and corresponding monitoring reports, see Appendix B

Verification
Companies would send the signed document to the CDM Operating Entity for the SHS-CDM project (either directly or through a third party, as discussed in Chapter 4). The Operating Entity would then verify the document's authenticity and include it in their verification report.

To avoid double counting and facilitate verification, the project team suggests using a central electronic database for PV modules registered for SHS applications in the CDM. The database would 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. This should enable the detection of attempts to register the same module more than once and would provide the basis for random or targeted spot checks to confirm the sale of specific modules to companies registering those modules with the CDM.

Benefits and constraints of the proposed procedure
Transaction costs:
- The major advantage of this system is that transaction costs are very low compared to any of its alternatives. The considerable reduction in transaction costs can be achieved because the system makes use of existing procedures in the SHS industry rather than trying to develop a parallel system for verification.

Simplicity:
- The system is relatively simple to execute, provided that appropriate instructions are given to the participating companies. The system does require co-operation from the local accountant/auditor and from the PV manufacturer. However, both have an incentive to co-operate.
- A drawback of this system is that it excludes companies that are not yet audited. Feedback from some SHS companies indicated that in some countries companies do not need an audit if they do not make profits. The companies stated that they did not see this as a barrier as the costs of hiring an auditor are relatively minor compared to the potential benefits. Nevertheless, requiring an audit may still be a barrier for smaller companies, but participating in the CDM will always require a minimum level of administration. If there is no system of record keeping in place to be verified by an auditor, it is hard to imagine that a company will have the capacity to participate in the CDM.

Credibility:
- Since this verification procedure makes use of the existing auditing structure in the host country, it's credibility is as good as the credibility of that structure. Most respondents interviewed thought that the credibility of financial auditors is generally high and certainly higher than other administrative structures such as tax collection. Most respondents thought this procedure was suitable for CDM verification purposes. As one participant noted: 'It is hardly imaginable that any CDM auditing and verification system would be more fraud proof than the existing financial auditing standards in a country.' There are a number of observations in this regard:
  - Since CER revenues per system are likely to be relatively small there is less incentive for cheating as compared, for instance, to GEF subsidies on SHSs, which are generally much higher.
  - Cheating in auditing reports is in most counties a criminal offence and can be dealt with by the courts.
  - Auditors are not likely to accept bribes since their reputation for independence is crucial to their core business.

2.2.2 Monitoring of system availability

Phase I of this study recommended discounting system availability to account for system downtime and failure, and suggested a conservative average availability factor of 70%. Making such an adjustment upfront would remove the need to monitor system availability at the project level before disbursing CERs, thus substantially reducing transaction costs, because monitoring could happen at a global level, opening up the potential for economies of scale and combining it with verification. The problem with this approach is that it implicitly assumes up-front approval of the credits that would be generated. As discussed under Credit Disbursement (under 2.3.2), many experts and stakeholders believe upfront crediting is against the nature of the CDM and is not likely to be accepted. This implies that system availability will have to be monitored on the project level.

Proposed monitoring procedure

There are basically two options for monitoring system availability. The first option is that SHS companies could organise and conduct system performance monitoring themselves. This option might especially be efficient for SHS companies that have after sales service contracts with their customers and thus already have a system of performance monitoring. This is especially likely for companies operating under fee-for-service or that provide credit to their customers.

The second alternative is to have an independent third party implement the monitoring of the system availability. This approach might enable the reduction of transaction costs as monitoring and verification efforts could be combined. Hiring independent experts and involving the Operating Entity in the monitoring process could avoid the costs of verifying by means of a household survey. This would seem to be cost efficient in the case where household surveys would constitute a large part of the monitoring costs.

It is difficult to suggest the most optimal monitoring procedures, as the costs in relation to the credibility of the procedures are really dependent on what type of business model a SHS company is operating.

With fee-for-service arrangements, revenue from system rentals would indicate system availability. Where non-payment is not directly tied to lack of system availability, fee-for-service operators could have the option of distinguishing non-payments from operational problems if they could supply verifiable records (e.g., regarding service requests). Where pre-payment for service is employed, payment would indicate system availability without exception.

For credit sales, continued payments over the loan period could potentially be used to indicate system availability. Companies could have the option of distinguishing non-payments from operational problems if they could supply verifiable records (e.g., regarding service requests). Once loans are repaid, if CDM rules require continued checks on system availability for credit disbursement purposes, system availability would be confirmed in the same way as cash sales (see below).

For cash sales, system availability would be checked by site visits to a random sample of households. For efficiency, system operations would be confirmed by simply asking a household member if their SHS is still working. Sample sizes should be kept to the minimum required to meet the standards for such projects in the CDM.

Verification

Where monitoring is conducted independently by SHS businesses, verification might be implemented through verification of the service contract records of the involved companies where available. When necessary random or targeted spot checks could be included, conducted by independent local third parties who are hired by the Operating Entity.

Where an independent third party does the 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.

Benefits and constraints of the prospective procedures:
Transaction costs:
- When SHS companies have an extensive administration record of service contracts, the transaction costs of verifying that record might be quite limited. Procedures for monitoring system availability in fee-for-service operations that rely on existing documents can reduce costs and be verified though local auditing. When statistical sampling and field surveying are necessary, having an independent third party verify system availability could lower the combined costs of monitoring and verification.
- The costs of field surveying could probably best be minimized by limited the number of required field visits, for example by having periodic crediting at intervals of greater than one year rather than annual crediting.

Credibility:
- The exact details of how monitoring and verification procedures should work depend on the specific characteristics of the SHS companies involved, and should, hence, be detailed in the project design document. The credibility of the proposed monitoring procedures should be established in the validation phase.

2.2.3 Estimation of fuel savings
The global standardised emission reduction factor used in the standardised CER calculation formula in Section 2.1.5 has been established from Phase I data 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 UNFCCC and then maybe go to national emission reduction factors over time.

Proposed monitoring procedure: the global monitoring approach.
We propose 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 would 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.

The monitoring methodology will involve tracking a sampling of systems to gather information on relevant fuel use before and after SHS installations (and possibly on system operational performance over time, as discussed below). 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 will 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 would organise and conduct surveys of a random sample of SHS households, stratified by system size. Preferably they would do this in collaboration with the companies engaged in SHS-CDM project activities. It is important to hold this survey within 1 year after the system has been sold in order to reduce the influence of rebound effects (see also rebound discussion in 2.3.5.).

The person conducting the survey would 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 would 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 given level of confidence and precision. Preliminary calculations indicate that 5% of CER revenues of SHSs would be enough to sample 1% of the SHSs sold. Compared to the current amount of empirical information available on the use of SHSs in the field, this would substantially increase the amount of information on the performance of SHSs. Costs of such a procedure could be reduced by using local researchers (e.g., from NGOs, universities, public agencies).

There may be opportunities to reduce the cost of these household surveys by combining them with the household surveys implemented under monitoring of system availability. That may be especially relevant if an independent third party also monitors system availability.

Project related kerosene monitoring

In case no standardised baseline is accepted by the UNFCCC, or where project developers opt to use a project specific baseline, the CDM project developer will have to execute the monitoring of kerosene fuel savings, but could still follow the above procedures. As with project monitoring of system availability, also here they could choose to have this done by an independent third party.

Verification

An independent research team, under guidance of an Operating Entity or the UNFCCC Executive Board, would implement the monitoring study used to update the global emission reduction factor.

Benefits and constraints of the proposed procedure

Transaction costs:

- If the 5% levy on CER revenues is sufficient to have a large enough sample as our current estimates indicate, then the transaction costs of this approach are limited.

Simplicity:

- As mentioned above one of the main reasons to engage in a global monitoring approach is to reduce the complexity of CDM procedures for SHS companies.

Credibility:
- Credibility is ensured by collecting empirical field data and following the standards set by the UNFCCC or Operating Entity.

2.3 Other possible items for fast-tracking small projects

In this section we include a number of proposals that could potentially help to facilitate the participation of SHSs and other small projects in the CDM. The most prominent are additionality testing and credit disbursement.

2.3.1 Additionality testing

'Additionality' relates to whether activities will be eligible to participate in the CDM. Article 12 of the Kyoto Protocol states that emission reductions can be credited only if they 'are additional to any that would occur in the absence of the certified project activity.' Commonly, 'additionality' is interpreted to mean that the credited activity must itself be additional to what would occur without the CDM. To maintain the environmental integrity of the Kyoto Protocol, it is generally accepted that emissions reductions should be credited for activities that are not expected under business-as-usual.

Regarding the prospective additionality of SHSs, with a total of about 1 million SHSs installations to date compared with 300 to 400 million un-electrified off-grid homes in non-Annex I countries, SHSs have not yet made significant inroads into developing-countries. Many countries have almost no experience with SHSs. Even where SHS activities are most advanced, (e.g., Dominican Republic and Kenya), penetration is still only about 2-4%. Several barriers constrain SHS markets, including high upfront system costs, lack of consumer credit to enable system financing over time, lack of system availability and adequate maintenance services in rural areas, and limited information and knowledge about the technology.

Options

The options for determining the additionality of SHSs and other small-scale renewable energy activities will most likely depend on decisions made by the COP or CDM Executive Board. Past and recent negotiating texts suggest four possibilities for additionality testing:
- *Emissions Additionality*, where projects must demonstrate that their activities result in GHG reductions to qualify for the CDM.
- *Categorical Additionality*, where projects of designated types would qualify for the CDM. Categorical additionality for small-scale renewable energy projects has been suggested by means of a positive list and more recently by special 'fast track' rules for CDM qualification.
- *Additionality via Barrier Removal*, where projects would need to demonstrate that, due to investment and/or implementation barriers, they are additional to what is expected under business-as-usual. Projects that help to overcome barriers would be CDM eligible.
- *Economic/Investment Additionality*, where projects must demonstrate, through an individualised analysis, that they would not occur without the generation and sale of CERs. Such an analysis might require showing that a project's risk-adjusted internal rate of return would be below a certain limit without added revenue from CER sales.

Benefits and constraints of certain options

Additionality rules will have important ramifications regarding the types and probably the scale of SHS activities that will be able to participate in the CDM.

Emissions Additionality
The Marrakesh Accords have chosen a fairly general definition of additionality:

> *'A CDM project activity is additional if anthropogenic emissions of greenhouse gases by sources are reduced below those that would have occurred in absence of the registered CDM project activity (UNFCCC, 2002, art. 43)'*

Some view this definition as simply requiring emissions additionality: if the project's emissions are lower than the baseline, the project meets the additionality requirement. This would imply that most renewable energy options would be automatically eligible under the CDM. Most likely, however, project developers will also have to show that their project would not have proceeded without the CDM. It is ultimately up to the CDM Executive Board to provide an unambiguous interpretation of this definition.

Categorical Additionality Under recent proposals, SHSs would qualify for 'fast track' rules that would give automatic CDM eligibility to small-scale renewable energy activities. Given the low global level of SHS deployment at present and the very small risk to the environment from crediting non-additional SHS installations, this option trades off easing CDM participation to accelerate SHS deployment for the likelihood of some free rider installations that would have occurred anyway.

Additionality via Barrier Removal Rules requiring that additionality be demonstrated via barrier removal could potentially exclude certain elements of the SHS market, but could be structured to keep costs down for qualifying activities if the factors determining eligibility are simple enough to allow consistent and objective application. This would be possible using screening techniques to distinguish between SHS installations that are most likely to make a valuable contribution to removing dissemination barriers from ones considered to be 'business as usual'.[5] This approach could encourage activities that would most likely offer the greatest potential for GHG abatement in the long term. The approach trades relative simplicity for probably at least some free-rider installations. The environmental consequences would be fairly insignificant and might be more than offset by the market catalytic nature of a CDM framework that encourages and helps to accelerate SHS dissemination.

Economic/Investment Additionality While this could theoretically best safeguard the global environment, it could constrain commercial SHS activities most likely to have lasting GHG benefits. Commercial distribution channels have often been the most successful and sustainable approach for disseminating SHSs to users, through methods ranging from cash sales in open markets to private energy service company operations. The extent to which SHS activities will be additional in the commercial marketplace will be affected by the rate of market development, the willingness of private parties to invest in distribution channels, and the willingness of entrepreneurs to participate in the SHS market at given levels of risk and financial return. The additional revenue from CERs could be used to make SHS business activities more profitable, thus encouraging new and additional investments to expand SHS operations or draw more companies into the business. As explained in the next paragraph, CER revenue could also be used to provide new or improved aftermarket services to SHS customers or lower system costs in a way that would increase consumer demand. Either way, those factors will be difficult to assess accurately and consistently on a case-by-case basis.

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[5] Specified categories of activity could be used to indicate additionality. For example, activities could be considered additional if they 1) provide consumer credit for system purchases, helping to overcome the first-cost barrier; 2) provide SHSs on a fee-for-service basis, helping to overcome the first-cost barrier and ensuring long-term maintenance; 3) provide training and/or business development services for SHS businesses, helping to overcome the barrier of system availability (in this case, CERs would be generated by installations from assisted businesses; this may be hard to track and would require safeguards to avoid double-counting); and/or 4) help to expand cash sales of systems meeting certification or quality criteria, until a predetermined level of market penetration is achieved, either at the national or global level.

Economic/investment additionality testing could be more difficult for SHS–CDM projects than for many other types of CDM projects because SHSs are consumer goods rather than a one-of-a-kind investment. As consumer goods, CDM assistance could affect the degree of market penetration rather than 'go, no-go' types of decisions about the total investment. Even without any additional support, a SHS business might still reach, say, 10% of its potential target group. By providing additional services such as consumer finance or after-sales services, the company could potentially reach 20 to 30% of its target group. If such additional services were made possible by CDM revenues, it is clear that CDM would have an 'additional' impact on SHS sales. Yet, it is very difficult to determine which sales are not additional (the first 10%) and which are.

Favoured option
The project team favours categorical additionality for small-scale renewable energy activities, in which case SHS installations would be considered additional for CDM participation purposes.

2.3.2 Credit disbursement

While CERs represent a financial means to stimulate SHS activities, the benefits will be sensitive to the method of credit disbursement. The CDM negotiating texts have generally specified that emission reductions would be certified and CERs issued on an ex post basis. In the context of small-scale renewable energy activities, stakeholders from the industry indicated that CERs would have their greatest value if they could help to overcome the barrier of high upfront costs. An exception that allows for upfront crediting would be a tremendously helpful part of 'fast track' procedures, if such an exception was acceptable.

Credit disbursement timing will have important ramifications for both CER investors and SHS-CDM project participants. The net present value of credits received ex post over the course of the project would be 67% of the value of the credits if received upfront assuming a discount rate of 10% and a crediting time of 10 years. This figure would diminish rapidly at higher discount rates that may apply in the case of projects such as SHS involving thousands of very small systems operating in sparsely populated areas, often in poor countries. It would further diminish if CERs are not issued every year, perhaps due to monitoring and verification only being done every few years in order to keep costs down.

Options
There are roughly 4 options for credit disbursement:
- Annual Crediting
- Periodic Crediting
- Full Upfront Crediting
- Partial Upfront Crediting

Annual Crediting. The investor would get CERs on an ex post basis for each year that the SHS is in operation. This option would require an annual check on system availability. This is a very safe and conservative method, ensuring that all credits represent actual CO_2 abatement. However, annual crediting would have high transaction costs. Also, given the very small revenue per year, small SHS companies would have little incentive to participate in and benefit from the CDM.

Periodic Crediting. To reduce the transaction costs associated with annual crediting, SHSs and other small-scale projects might benefit from rules that enable credit disbursements at intervals that are greater than annual. For example, disbursing credits every three or five years would reduce monitoring and paperwork costs, while still only crediting emission reductions on an ex post basis.

Full Up-front Crediting. If all CERs that an SHS would accrue over the crediting period are paid immediately after installation, the financial benefits to market participants and SHS users are maximised. This could result in decreasing the up-front investment for a SHS by 5 – 20%, thereby decreasing the current largest barrier to widespread market development. It could also have the greatest impact on SHS business profitability and provide the best chance of bringing new investments in existing SHS companies or new companies into the SHS business. This approach would also be simplest, requiring the least amount of paperwork and overhead. This option risks supplying credit beyond the actual life of a share of SHSs. For example, systems may break down or stop being used prior to the end of their crediting lifetime. But, where coupled with standard abatement values that apply factors to account for operational failures based on empirical studies, longevity would be accounted for and the risk of over-crediting would be mitigated. Furthermore, even if some over-crediting were to occur, the environmental consequences would be insignificant.[6]

Partial Up-front Crediting. To receive more benefit from the CDM than is offered by annual crediting, SHSs could be provided partial up-front crediting. If CDM regulations allow for disbursing a portion of future credits from SHSs upfront, this would have the benefit of helping to address up-front investment costs for SHSs while maintaining an ex post credit requirement for the balance of CERs. This approach would include at least one checkpoint for CDM operational entities to confirm that SHS activities are progressing as anticipated before releasing CERs for the full credit life of the systems. The transaction costs associated with this option are lower than annual crediting, while still a checkpoint is built into the implementation process.

Benefits and constraints of options

On the issue of upfront crediting, feedback from stakeholders was mixed. Most proponents of small projects and SHS stakeholders were generally in favour of upfront crediting. Most climate/baseline experts, however, thought that upfront crediting would not be acceptable under the CDM. They argued that ex post crediting defined the very nature of CO_2 emission crediting. If credits were given upfront, then the CDM would become merely an investment subsidy. Another argument is that small projects or SHSs are not faced with an additional barrier as compared with larger projects when it comes to ex-post crediting. If they need upfront cash they could try to seek arrangements with the carbon investor or a financial intermediary and receive the discounted value of the credits.

The argument that small projects are not faced with an additional barrier related to ex-post crediting is not supported by the project team. We believe that SHS companies do face additional barriers with regard to ex-post payment, because of the dispersed nature of SHSs in the field. That makes it particularly difficult to transform an expected cash-flow based on CERs into upfront payment from a bank or other financial intermediary. The scattered nature of their installations in remote areas and the lack of collateral on these assets make the future CER cash-flow a much higher risk investment than the CER cash-flow from a power plant or industrial facility. Banks will therefore ask higher risk premiums for such projects if they consider them at all.

Proposed option

As upfront crediting is unlikely to be granted, even for small projects, arrangements to enable upfront payment for CERs would help SHS operations to receive benefit from CDM participation. This may require that CDM investors take the risk of paying upfront for CERs that may never materialise, in which case they would presumably discount their payment for future CERs significantly. To increase the attractiveness of this option, it may be desirable if at least some

[6] The total environmental risk is limited. If we assume that globally 250,000 new SHS installations will participate each year and the risk of overestimating carbon abatement is 100 kg per system, then total potential free-rider CERs would equal just 25,000 metric tonnes annually, roughly equivalent to annual emissions from a 5 MW oil-fired power plant.

element of partial upfront crediting would be considered as a favourable treatment to SHSs. Alternatively, some other entity, such as a special purpose organization or project aggregator might assume the risk by guaranteeing that CERs will be delivered (see Chapter 4).

2.3.3 Exclusion of projects receiving GEF and ODA support

Often, CDM negotiating texts have included rules that would exclude project activities that receive money from the GEF and official development assistance (ODA). The inclusion of such rules could impact the ability of some SHS activities to participate in the CDM. There are over 20 GEF projects supporting SHS activities in numerous countries, including projects such as the Solar Development Group and Photovoltaic Market Transformation Initiative that target multiple countries. Furthermore, several countries have provided bilateral support for SHS and other rural renewable energy activities.

Funds from the GEF, ODA, and private philanthropy have provided an important source of support for SHS programs and will likely continue to do so in the future. By financing such activities as market studies, training, capacity building, and revolving fund seed capitalization in precommercial and emerging market environments, this funding has helped to build sustainable SHS activities in many countries.

If project activities supported by GEF and ODA are excluded from the CDM, the project team suggests that the rules to determine which SHS activities are excluded should be simple, clear, and fair. CDM rules could exclude eligibility for SHS installations that are directly financed with GEF funds, via loans or direct grant subsidies.

Recommendation
While carbon reduction credits generated by the SHS-CDM projects should not be purchased with ODA money, all other SHS activities benefiting from GEF and ODA should be eligible. Eligible activities should include SHS installations in countries that have received GEF and/or ODA support to promote SHS activities and build markets as well as installations by businesses that have received investments from GEF and ODA sources, as long as the individual CDM participating SHS installations are not directly subsidized or financed by GEF or ODA.

2.3.4 Streamlined host country approval process

Host country approval is an important mechanism to ensure that CDM projects meet local development priorities. At the same time, lack of capacity within host country governments may make their approval a barrier to the smooth processing of CDM participation for SHS-CDM projects. Another barrier is that since SHS activities are relatively small, extensive approval procedures are likely to be a higher burden for SHS companies as compared to larger CDM projects. That would be unfortunate, because SHSs projects as well as other small projects generally score high on the priority list of developing countries. There may thus be scope to consider how host country approvals could be organised to ensure quick approval of priority projects like SHSs.

One option to streamline host country approval would be to develop, under the fast-track procedures, a priority list of project categories that are generally believed to have a high development impact. Countries could sign up to participate in this list and approve qualifying projects categorically to generate and sell credits, provided that they meet the standards as controlled by the Operating Entity, while refraining from interference at the project level.

2.3.5 Leakage, rebound, lifecycle emissions, and growth baselines

Leakage, rebound, lifecycle emissions, and growth baselines are commonly discussed issues that can potentially affect the carbon abatement attributable to project activities. These issues also have a bearing on process streamlining, since baseline studies can be more or less complicated depending on whether, and to what extent, they address these issues.

Leakage: Leakage is the impact on GHG emissions outside of a project's boundary that can be attributed to the project's activities; it can be positive or negative. Leakage might be relevant in the case of SHSs if kerosene is scarce and, under the prevailing prices, demand for kerosene cannot be satisfied. The kerosene not consumed by households with a SHS might then be used elsewhere. Leakage affects might also be positive where SHS activities, supported in part through participation in the CDM, help to catalyse other SHS installations that do not participate in the CDM. Overall, leakage is expected not to have a significant impact on emission reductions from SHS activities; therefore, attempting to accurately quantify leakage effects for SHS installations seems excessive and unnecessary and will probably not be required.

Rebound effect: Rebound effects are commonly mentioned in the context of energy efficiency activities, where the benefits of reducing the electricity consumed by individual appliances are sometimes offset by overall increases in energy service levels and energy consumption. Some have suggested that similar impacts occur with SHSs, where the systems supply electric lights yet people sometimes continue using some amount of kerosene for lighting, partially offsetting the potential kerosene displacement benefits. The project team's recommended monitoring methodology for kerosene savings (see Section 2.2.3) specifically accounts for continued kerosene use after SHS installations, using empirical factors where household survey data exist and applying adjustment factors where project-specific data are absent; its does not, however, discount for possible increases in kerosene lighting over time based on such variables as increased family income that are independent of SHS performance.

Lifecycle emissions: Studies comparing the emissions that result from manufacturing solar home system components (i.e., PV module and batteries) over systems' lifetimes with the upstream emissions from the fuels they replace find that, on average, these upstream emissions are roughly equal and cancel each other out. While the exact relationship will depend on the module and battery technologies used (in some cases, upstream SHS emissions will exceed those of the replaced fuels and in others they will be exceeded by them), several experts interviewed suggested leaving lifecycle analyses out of emission reduction calculations for SHSs since such analyses will not generally be included for other CDM activities. The Marrakesh Accords say project boundaries shall encompass GHG emissions under the control of the project participants that are significant and reasonably attributable to the project activity (see UNFCCC, 2002, paragraph 52). So, lifecycle analyses would probably not be required.

Growth baseline: Growth baselines are intended to reflect anticipated changes in energy consumption over time. Studies report that newly electrified households often increase their level of electricity consumption over time as they acquire new electricity-consuming appliances. With regard to the domestic fuels typically used in the absence of electricity, such as kerosene lighting and car battery charging, the project team is not aware of any empirical evidence to suggest how consumption patterns would be expected to change over time. Therefore, to be conservative, where domestic fuels are used as the baseline reference case, we do not suggest that growth baselines be used.

Under a global system for monitoring the emission reductions attributable to SHSs, further information could become available to better understand how the issues discussed above relate to the emission reduction attributes of solar home systems.

3. ALTERNATIVE OPTIONS FOR SHS CDM PARTICIPATION

Depending on the rules established by the COP or the CDM Executive Board, and the preferences of SHS-CDM project developers for the options presented in Chapter 2, a range of different alternatives for streamlining CDM procedures for SHS are possible. In general, one can assume that opportunities for streamlining CDM participation processes will decrease as the applicable rules become more project-specific and stringent, and accuracy and accountability at the project level increases. Figure 3.1 explains this principle diagrammatically.

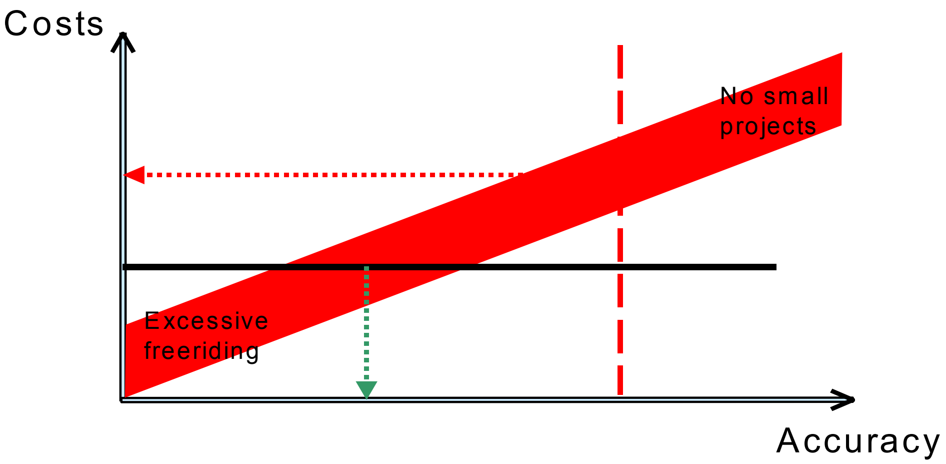

Figure 3.1 *Transaction costs of CDM procedures and accuracy (Source: IT Power, 2001)*

The key issue with regard to selecting the appropriate set of streamlined CDM procedures is the trade-off between environmental integrity and transaction costs. Insisting on too high levels of environmental integrity may kill off many projects. That would be especially unfortunate if these are project categories with clear benefits for long-term climate policy and clear sustainable development benefits, as is the case with most small-scale renewable energy activities.

The following two Sections, 3.1 and 3.2, discuss different alternatives for streamlining CDM procedures for SHS. Section 3.3 presents an estimate of the transaction costs of each of the alternatives assuming different SHS-CDM project structures.

3.1 Alternative streamlined procedures for SHSs

Based on the review of options in Chapter 2 different alternative packages of streamlined procedures could be selected. In this section we first discuss the key determinants to distinguish between different packages and then compile 6 different alternatives, based on both project baselines and standardised baselines.

Baselines

The most important distinction is whether SHS-CDM projects will be allowed to use standardised baselines. Standardisation could happen at different levels: globally as we propose or on a regional or national level.

If no standardisation is allowed, project baselines could be used. As was suggested by a few respondents during interviews, the global standardised baseline could also be used for validation purposes only. In that case the emission reductions will be estimated in the validation study using a global emission reduction factor. The actual credits will be disbursed based on project related monitoring figures. The advantage is that costs are saved in the project development phase, against the costs of higher uncertainty of what the real credit proceeds might be.

A final distinction that can be made within project baselines is between multi-SHS company baselines and a single SHS company baseline. This distinction is made since many SHS-CDM projects may include the installations of more than one SHS company. Hence the option exists to include one baseline for all the companies involved in a given SHS-CDM project or to have each company establish its own baseline for CO_2 savings. This latter option would be the most disaggregated (and therefore likely to be the most costly) of all baseline options.

Monitoring and Verification
As was mentioned in Section 2.2 on project monitoring, the optimal M&V procedures for a SHS-CDM project will depend on project characteristics such as whether systems are distributed under fee-for-service, credit, or cash type of operations. In describing the alternatives, we assume that each company will adopt the most streamlined procedures applicable to it. In our analysis of the transaction costs we will go into more detail on the cost implications of M&V procedures for different types of SHS businesses.

Up-front or ex-post crediting
At the moment of writing it is not yet clear to what extent a certain degree of upfront crediting may be possible under the CDM. Upfront crediting was, however, an integral part of the first proposal as developed in our phase I report. Also, during phase II a number of stakeholders expressed support for it. Hence we include streamlined procedures based upon upfront crediting as one alternative.

Bundling
Bundling of projects is also an important feature for SHSs given the relatively small size of most SHS operations. We assume this feature is an option in all the alternatives for streamlined procedures.

Possible simplified CDM procedures for SHS
The different baseline methodologies in combination with the possibility of upfront crediting provide 6 alternative packages of streamlined CDM procedures for SHSs (see also Table 3.1):

- Standardised alternatives
  1. standardised baseline based on upfront crediting and using a global emission reduction factor
  2. standardised baseline using a global emission reduction factor
  3. standardised baseline using a regional or national emission reduction factor.
- Project related alternatives
  4. project baseline using a standardised factor for validation
  5. project baseline using one baseline for all included SHS companies
  6. project baseline using a separate baseline for each of the included SHS companies.

In the first alternative, CDM rules would allow the use of standard abatement values over the crediting life of projects in selected categories, including SHS, and would enable upfront crediting or its equivalent. Regardless of whether the abatement value is set at the global, regional, or national level, this alternative would provide project participants with the most highly streamlined CDM participation procedures. Only the reporting of system deployment would be needed for credit at the project level. To maintain environmental integrity, monitoring of the key assumptions underlying the standard abatement value should be conducted to enable periodic revisions to the abatement values that would apply to new system installations.

In the second and third alternatives, the CDM would allow standardised baselines (respectively global or regional/national) but require ex post crediting based on monitoring reports of system availability. As with alternative 1, the project team suggests that additional monitoring should be conducted to enable periodic revisions of the key assumptions underlying the standard abatement values.

The fourth alternative assumes a SHS-CDM project baseline, but would allow the use of standard abatement figures for project validation (i.e., project design documents could use standard baseline figures). CERs would be based on monitoring reports of actual fuel savings and system availability.

The fifth alternative would require a SHS-CDM project level baseline to be set upfront for project validation; CERs would be based on monitoring reports of actual CDM project specific fuel savings and system availability.

The sixth alternative would require a SHS company level baseline to be set upfront for project validation, even within multi-company SHS-CDM projects; CERs would be based on monitoring reports of actual CDM project specific fuel savings and system availability.

Table 3.1 *Streamlined CDM procedures for SHS*

Alternative	Baseline	Monitoring & Verification	Crediting	Comments
1. Standardised - Upfront	Standardised baseline using a global abatement value	- *Reporting of systems deployed*: use accountant declarations, see 2.2.1 - *System availability*: independent monitoring team or SHS company with independent verification, see 2.2.2 - *Kerosene savings*: UNFCCC guided independent monitoring team, see 2.2.3	Upfront	Upfront crediting is not likely to be accepted under the CDM
2: Standardised - Ex Post global	Standardised baseline using a global value	- *Reporting of systems deployed*: see 2.2.1 - *System availability*: see 2.2.2 - *Kerosene savings*: see 2.2.3	Ex Post	This is our most preferred scenario. Outcome dependent on acceptance of standardised baselines by CDM Executive Board
3: Standardised - Ex Post national	Standardised baseline using regional or national values	- *Reporting of systems deployed: see 2.2.1* - *System availability: see 2.2.2* - *Kerosene savings*: see 2.2.3 (monitoring team would be national)	Ex Post	If more country specific information becomes available on SHS, national standardised baselines could become a preferred alternative to a global baseline.
4: Project - Streamlined validation	Project baseline Global emission reduction value is used for validation	- *Reporting of systems deployed*: use accountant declarations, see 2.2.1 - *Kerosene savings & System availability*: Project specific (by SHS-CDM project developer or by independent team)	Ex post	High uncertainty about quantity of CERs because validation figure is not related to project
5: Project - Multi-SHS company baseline	Project. Aggregated project baseline for all SHS companies bundled into a project	- *Reporting of systems deployed*: use accountant declarations, see 2.2.1 - *Kerosene savings & System availability*: Project specific (by SHS-CDM project developer or by independent team)	Ex post	Higher transaction costs for estimating project baseline, but more certainty about future CER flow than option 4
6 Project - Single SHS company baseline	Project. Separate baseline for each of the included SHS company	- *Reporting of systems deployed*: use accountant declarations, see 2.2.1 - *Kerosene savings & System availability*: Project specific (organised by SHS-CDM project developer, executed by SHS company)	Ex post	Most disaggregated alternative, but ensures that each company gets credited for what they reduce. Higher transaction costs are likely.

3.2 Estimated transaction costs and ramifications for SHS participation

The main costs for SHS-CDM projects will include the cost of preparing a project design document, validation (if project participants need to pay the Operating Entity (OE) for validation services), preparing documents to report on systems deployed, monitoring, and verification. These costs will vary for each alternative presented above, affecting the ability for SHS activities to benefit from CDM participation at different project sizes, CER prices, and credit period durations.

Based on the suggested streamlining methods outlined above, the project team believes that efficient CDM rules and structures can enable transaction costs for small-scale activities such as SHS to be significantly lower than commonly estimated. Estimates of participation costs based on CDM structures commonly proposed have generally been quite high; a sampling of CDM participation cost estimates (Bosi, 2001) indicates a range of \$40,000 - \$90,000 to prepare a project design document and obtain host country approval and in the range of \$400,000 – \$1,000,000 over the CDM project cycle. Each of the alternatives presented above would provide some cost savings compared to what would be expected without any streamlining, though savings would vary substantially depending on the alternative.

In this section, a first attempt has been made at estimating the transaction costs of six different scenarios (see 3.2.1) and to identify important variables that will impact the transaction costs for SHS-CDM projects (see 3.2.2).

3.2.1 Transaction costs of potential SHS-CDM projects

The cost of preparing and validating a project design document will depend on the level of aggregation used in baseline setting and the level of complexity required for monitoring and verification plans, as well as requirements for additionality testing and the difficulty of obtaining host country approval. The alternatives presented above vary mainly with regard to baseline setting and monitoring requirements, which would affect the time and resources needed to prepare baseline studies and to prepare and implement monitoring and verification plans.

In order to analyse and compare costs of the different alternatives, we have assumed that the following components of the project cycle could generate transaction costs:

1. Project Design
   - General description
   - Additionality testing
   - Baseline setting
   - M&V plan
   - Host country approval.
2. Validation
3. Registration
4. Monitoring
   - Reporting of systems deployed
   - Monitoring of system availability
5. Verification

Generalising about transaction costs for SHS-CDM activities is in principle quite difficult, given the wide variety in possible SHS-CDM projects. In order to produce some indication of transaction costs, we have defined two examples of prospective SHS-CDM projects to illustrate the impact of the different cost components. Table 3.2 summarises the major assumptions for each project category and Table 3.3 summarises the cost assumptions used in the calculations.

SHS–CDM project I illustrates a quite large-scale fee-for-service project renting on average 50Wp systems. Due to maintenance contracts with the end-users, we assume a high degree of system availability: 95%. Actual system availability can be monitored using records from requests for maintenance and the execution of maintenance activities. We assume that SHS-CDM project development is executed under the guidance of an international consultant.

SHS–CDM project II illustrates a project comprised of a bundle of five different companies in five different countries, each selling their systems on a cash sales basis, with an average 30Wp system size. System availability is assumed to be lower than project I and is on average 75%[7]. Because they do not keep an extensive monitoring administration, field trips are required to monitor system availability; we assume that an independent third party does these. The solar companies themselves execute the SHS-CDM project development with assistance from local consultants. We assume that any international assistance they might require to develop their SHS-CDM project is covered by donor assistance.

Table 3.2 *Assumptions for two types of SHS-CDM projects*

Assumptions	SHS-CDM project I	SHS-CDM project II
Annual sales	1 company selling 5000 system per year	5 companies selling 1000 systems per year.
Number of countries in project	1	5
Average system size (Wp)	50	30
System availability	95%	75%
Credit reporting	Every 2 years	Every 5 years
Monitoring charge for GERF	5%	5%
Sample size for system availability	1%	1%
CDM project development	International consultant	Local consultant
Project monitoring by:	Project participants	Independent third party
Sample size for GERF verification	1%	1%
CER price	US$ 10	US$ 10
Credit Period	10 years per system	10 years per system
CDM project operation time	Credits sold over 20 year period[8]	Credits sold over 20 year period

[7] A lower availability of cash sales operations is in line with findings reported in literature, see for instance Nieuwenhout et al. (2000).

[8] It is assumed that also after 2012 there will be a carbon market to sell SHS credits, whether called CDM or otherwise.

Table 3.3 *Cost assumptions for transaction cost analysis*

Assumptions	[US$/day]
International consultant	800
Local consultant	100
Local accountant.	300
Operating entity	1200
Cost per international trip (for 1 week)	2500
Average household surveys per day by local consultant	4

Table 3.4 and 3.5 summarise the major results of the analysis based on cost estimates developed according to alternative 2, i.e., assuming the use of standard global baselines and ex-post project monitoring and crediting.

Table 3.4 *Results in terms of CDM revenues*

Results	Project I	Project II
Total number (and MW_p) of rentals/sales of companies	50,000 (2.5 MW_p)	50,000 (1.5 MW_p)
Total SHS operating years credited with CERs	475,000	375,000
Total CERs	130,625	73,125
Value of all CERs [$]	1,306,250	731,250
Value of CERs after transaction costs [$]	1,077,350	479,813
Value per SHS [$]	21.55	9.60

Table 3.5 *Overview of estimated transaction costs*

Transaction costs	Project I	Project II
Project design	24,900	30,000
Reporting of systems deployed	37,000	24,000
Project related monitoring	101,688	160,875
GERF monitoring	65,313	36,563
Total	228,900	251,438
In % of CER revenues		
Project design	1.9%	4.1%
Reporting of systems deployed	2.8%	3.3%
Project related monitoring	7.8%	22.0%
GERF monitoring	5.0%	5.0%
Total	17.5%	34.4%

3.2.2 The implication of different streamlined monitoring packages

Taking the alternative packages identified in Section 3.1 as a reference, we now analyse the transaction cost implications of each of the packages for the two example projects. We will use the estimated transaction costs expected from alternative 2 (i.e., standard global baselines and ex-post project monitoring and crediting), as presented above, for purposes of comparison.
Crucial differences are related to:

- *Additionality* - The underlying assumption is that additionality will be categorical for small-scale renewable energy projects including SHS activities, or that additionality can be demonstrated through barrier removal using clear indicators of project eligibility by activity type. If this is not the case, and CDM rules require investment additionality to be demonstrated at the project level, it might cost in the range of $ 5,000 to $ 20,000 extra to prepare and defend additionality claims per project. In Table 3.6, we have assumed US$ 10,000 for additional consultant expenses for an additionality test. Furthermore, investment additionality requirements would potentially exclude a substantial portion of current SHS market activities from CDM participation.

- *Alternative 1, exclusion of project related monitoring* - Project monitoring clearly has a crucial impact on transaction costs. Upfront crediting would prevent the need for project specific monitoring and would thus make CDM participation far more viable for SHS activities, particularly at the smaller scale.
- *Alternative 4, 5 and 6, inclusion of project related fuel savings monitoring* – These options would be quite expensive. They would potentially require that 1% or more of the SHSs deployed in a project be surveyed to determine their kerosene savings. If we assume that 1% will be monitored (as we do for a global approach to this monitoring) then project-related monitoring costs are roughly equal for Project I and II: US$ 33,700.
- *Alternative 5 and 6, baseline validation* - We assume that a sample of 100 households will be required to estimate project-level baseline emissions. Doing a baseline study would become especially costly when several small projects are bundled together yet required to generate separate baselines; this would probably require baseline estimates from each small project's target areas, which could differ substantially.

The following two tables present the cost impacts of alternative streamlined procedures both for the costs of project development (Table 3.6) and impact on revenues per SHS and share of transaction costs (Table 3.7).

Table 3.6 *Impact of baseline study and additionality test on project design costs*

Alternative	Project development costs		Cost increase compared to standardised baseline	
	Project I	Project II	Project I	Project II
Standardised baseline (Alternative 1,2,3)	24,900	30,600		
Additionality test (all alternatives)	34,900	40,000	40%	33%
Baseline study (alternative 5,6)	39,500	78,000	59%	160%
Baseline and additionality	49,900	88,000	100%	193%

Table 3.7 *Transaction costs differences of different alternatives*

Alternative	Major adjustments:	Revenue per SHS (US$)		% transaction costs	
		Project I	Project II	Project I	Project II
Alternative 1	No project related monitoring	24.40	13.62	14.3%	17.5%
Alternative 2/3[9]	This is the reference case, so no adjustments	21.55	9.60	18.3%	34.4%
Alternative 4	Project related fuel saving monitoring	23.15	11.27	20.7%	38.5%
Alternative 5/6	Baseline validation plus project related fuel saving monitoring	22.85	10.31	21.7%	44.3%

Tables 3.6 and 3.7 clearly show the beneficial impact of baseline standardisation and streamlined monitoring. It is clear from both tables that the bundled CDM project consisting of smaller projects (Project II) will benefit most from baseline standardisation.

9 In this context, there are no real differences between alternative 2 and 3. The major difference is that alternative 3 requires development of national baselines, but that would be an activity executed before the project phase starts.

Without the proposed baseline standardisation and streamlined procedures recommended in this study:

- Project design costs could almost be three times higher
- Transaction costs could use up an extra 10% of CER revenues
- Transaction costs would account for about 20% to 40% of CER revenues, even for the large projects defined here for purposes of illustration, and could easily overwhelm CER revenues from smaller SHS-CDM projects.

Under the most streamlined option, which would include upfront crediting, transaction costs could be less than half of the costs of the least streamlined option.

3.2.3 Influence of individual CDM elements on transaction costs

For a number of specific determinants of SHS-CDM projects we have applied a sensitivity analysis with regard to transaction costs.

Crucial determinants

The transaction costs were highly sensitive for the following determinants:

- *Periodic monitoring* – The time interval at which monitoring occurs is a crucial determinant impacting the viability of SHS-CDM projects. Annual monitoring could be cost prohibitive, particularly for cash sales operations.
- *System size* – Given that monitoring-related costs increase with the number of systems but not with system size, system-size is an important determinant as it increases the net revenues per system.
- *CER revenues limited to first target period* – The period over which systems can generate and sell CERs is extremely important. Our analysis assumes that, after the first target period of the Kyoto Protocol, there will still be a carbon market in which CERs from the projects can be generated and sold. Thus, assuming a 10-year crediting period, systems installed in 2010 could generate credit until 2020. Limiting CER sales to the first target period reduces greatly the CER revenue per system.
- *Crediting period* – Crediting period will have an important impact on CER revenues. We assumed a ten-year period rather than the seven year period, twice extendable as provided for in the Marrakesh Accords, which could enable up to 21 years of CER generation. Crediting for 21 years would roughly double undiscounted CER revenues while the impact on transaction costs would vary depending on the alternative procedures applied.
- *CER price* - CER price is an important variable.

Secondary considerations

- *Number of countries involved* - While the number of countries involved does not substantially affect the estimated monitoring costs, this may be a limitation of the cost estimation model. In reality more countries within one project would increase communications difficulties and hence the smooth operation of the project. It is just hard to model such communication difficulties.
- *Number of systems in the project* - Given that there are some fixed costs, a minimum project scale is necessary for CDM participation to be viable. Above a certain size, however, this becomes less important since a considerable part of the monitoring costs are constant with the number of systems.
- *Costs of international consultants in project design and monitoring* - Given the big assumed differences in remuneration the transaction costs are quite sensitive to the employment of international consultants, and can be reduced to the extent that international consultants can be avoided. This is again an argument for baseline standardisation. A more simple methodology is likely to be more quickly executed by local consultants, thus keeping the costs of project design low. This also indicates the importance of local capacity building.

3.2.4 GERF monitoring

The transaction costs of GERF monitoring are divided between local experts reviewing the carbon abatement from solar home systems and costs of international coordination. The costs of the local expert are directly related to the number of SHSs they can visit in 1 day. Our current assumption is 4 systems per day. The 5% share of revenues for financing seems to be a reasonable amount to cover the costs of the local expert. Using our assumptions summarized above, the annual share of systems to be analysed for global monitoring could be around 1%.

4. ORGANISING SHS CDM PROJECTS

Even under streamlined procedures, CDM requirements for project participation are likely to be complex and technical. Large-scale SHS operations could certainly opt to organize their own CDM participation. Given the comparatively high fixed transaction costs likely for CDM participation, however, smaller SHS operations will probably participate only through some sort of aggregated arrangement. A project aggregator or special purpose umbrella organisation could help SHS businesses participate in the CDM.

An umbrella organisation could help to organise and facilitate CDM participation for SHS market participants by conducting some or all of the following three functions (see figure 4.1):

- Bundling SHS companies from different countries into one CDM project
- Organising the CDM procedures and administration
- Selling generated CERs on the international carbon markets

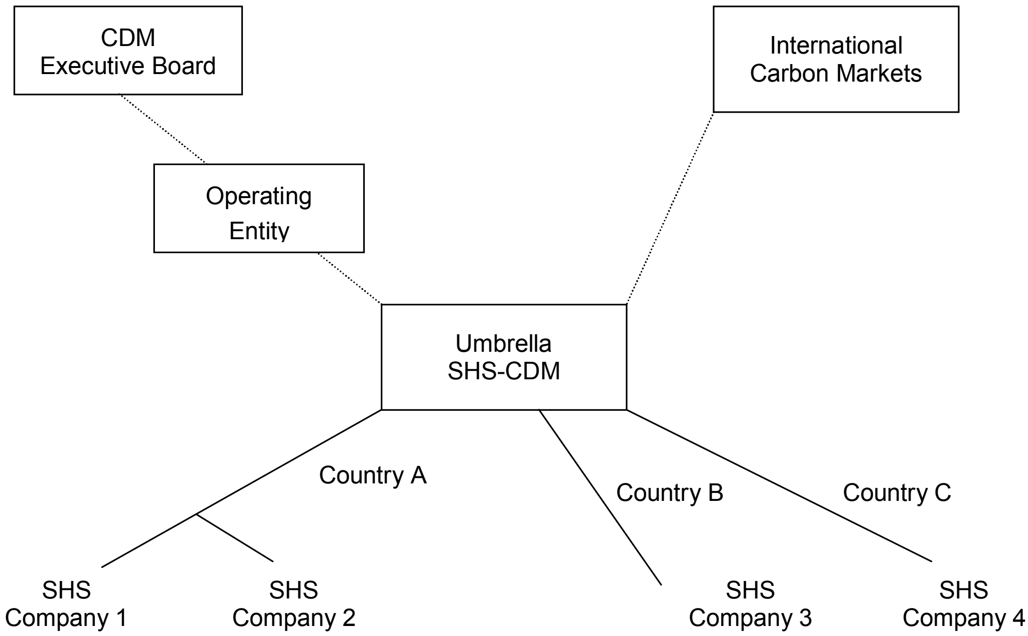

Figure 4.1 *Example of the umbrella organisation*

The tasks of organising CDM participation for SHS activities could be done by different entities or by a single umbrella organisation. Candidates for operating an umbrella organisation or dedicated special service window are:

- A new entity organized specifically for the purpose
- A multilateral development bank or institution (e.g., Prototype Carbon Fund of the World Bank or UNDP)
- International NGO (e.g., Greenpeace, European Photovoltaic Industry Association)
- Commercial operator
- Collaborating PV module producers.

In principle any of these entities could work as the umbrella organisation. Given the risks involved in the SHS market, some entities would probably not find this role very attractive. For example, given the small margins to be earned for SHS emission reduction credits, it is not likely that a commercial intermediary will engage in this activity. The most likely candidates are probably thus SHS companies organising themselves, the PV industry, NGOs, or development institutions.

4.1 Bundling SHS projects

The first task involved in bundling SHS projects for CDM participation would include raising awareness and engaging SHSs companies. The umbrella organisation could liase with the PV and SHS industry to raise awareness among relevant companies and explain the CDM participation requirements.

As a second task, an umbrella organisation could assist participating companies in coordinating with relevant stakeholders. For example, an umbrella organisation could seek project approval from the participating Non-Annex I countries. There could be important economies of scale from this activity, especially if more than one company from any given Non-Annex I country is participating. In such a case the umbrella organisation could aim to convince non-Annex I countries to approve CDM eligibility for all SHSs deployed in their country. An umbrella organisation combining projects from different countries and operating under explicitly defined rules to ensure that projects meet host countries' sustainable development criteria is likely to have more credibility and to be easier to monitor and approve than individual SHS companies.

A third important task for an umbrella organisation is to organise and streamline administrative procedures for SHS companies. The umbrella organisation could provide instructions to SHS market participants regarding the actions needed to receive credits and could help them through the process. In order to keep transaction costs low, making use of user-friendly databases via the Internet particularly seems to have a great appeal. By tailoring the administrative procedures to the operations of individual companies, the threshold for individual companies to participate becomes much smaller. Appendix C explains the required administrative procedures in greater detail. If such procedures were to be accepted, SHS companies could fill out a database with information concerning the systems they have sold and transfer the required information electronically, while the umbrella organisation could take responsibility for making sure that the applicable emissions reductions get transformed into CERs.

4.2 Co-ordinating CDM procedures

Tasks involved with coordinating SHS CDM procedures would include:
1. Organising project validation and registration. The umbrella organisation could seek approval from the appropriate CDM Operating Entity.
2. Organising monitoring and verification. The umbrella organisation could organise project monitoring and verification. It could also organize monitoring of the standardised carbon abatement values.

4.3 Facilitating SHS CER transactions

Facilitating SHS CER transactions would involve the following tasks:
- Finding buyers
- Assisting sellers
- Arranging upfront payment

4.3.1 Finding buyers

If SHS activities are to benefit from CDM participation, finding buyers for their CERs is critical.

Prospective CER buyers include:

- *Bilateral investors* - individual Annex I countries purchasing CERs under the CDM to meet their emissions target under the Kyoto Protocol, for example Cerupt.
- *Multilateral investors* – for example, the Prototype Carbon Fund.
- *Private investors* - private sector businesses looking for offset opportunities under the CDM.
- *Intermediaries* - dependent on resolving the fungibility issue in the negotiations, private sector intermediaries are likely to emerge to arbitrage between CER opportunities and demand for CERs. Such intermediaries can create added value by pooling projects to spread risks of mitigation options and lower transaction costs. An example of such an intermediary is the Triodos Bank Climate Clearing House.

An umbrella organisation could market the development benefits of SHS to governments, industry, and other interested carbon offset investors, and potentially attract a premium price for SHS credits (as is achieved in the market for green electricity). In this role, a multilateral umbrella organisation may have an added value above a national one, as it could mobilise resources from all Annex I Parties.

4.3.2 Assisting sellers

Tasks involved with assisting SHS CER sellers could include helping to prepare relevant documents and providing related guidance. For example, this might include assistance in responding to project tenders. Tenders are used to purchase a large quantity of credits at the lowest cost. They are normally geared towards large projects and thus are not very suitable for SHS activities, particularly at smaller scales. They involve additional up-front costs, which raise the associated transaction costs. Nevertheless, they may provide an opportunity for SHS to participate in carbon markets under the CDM, particularly if resources are available to defray the costs of preparing detailed proposals.

4.3.3 Upfront payment of SHS credits

One additional function of the umbrella organisation could be to make upfront payments for future CERs. Working with a range of SHS market participants in different parts of the world could help to diversify a SHS CER portfolio and reduce risk. Even if the umbrella organisation did not provide upfront payments itself, it could help to find a financial institution participating in the carbon offsets market that would.

5. SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

In order to facilitate the inclusion of off-grid renewable energy projects in the CDM, there is a need to promote simplified participation processes by developing standardised baselines and streamlined monitoring and verification procedures. In an attempt to fill this gap for SHS this study provides the following recommendations:

Standardised baseline using a global emission reduction factor

Supported by feedback from a wide range of stakeholders, it is recommended that the CDM guidelines include a standardised baseline for solar home systems based on a global emissions reduction value. Under the applicable guidelines, the working definition for SHS would be an integrated PV system comprised of a PV module, battery, wiring, and at least 1 light. The proposed CO_2 calculation formula for every SHS per year would be: 75 kg CO_2 per system plus 4 kg CO_2 per Wp. The emission reduction formula would be applicable to SHSs with capacities of 10 to 100Wp.

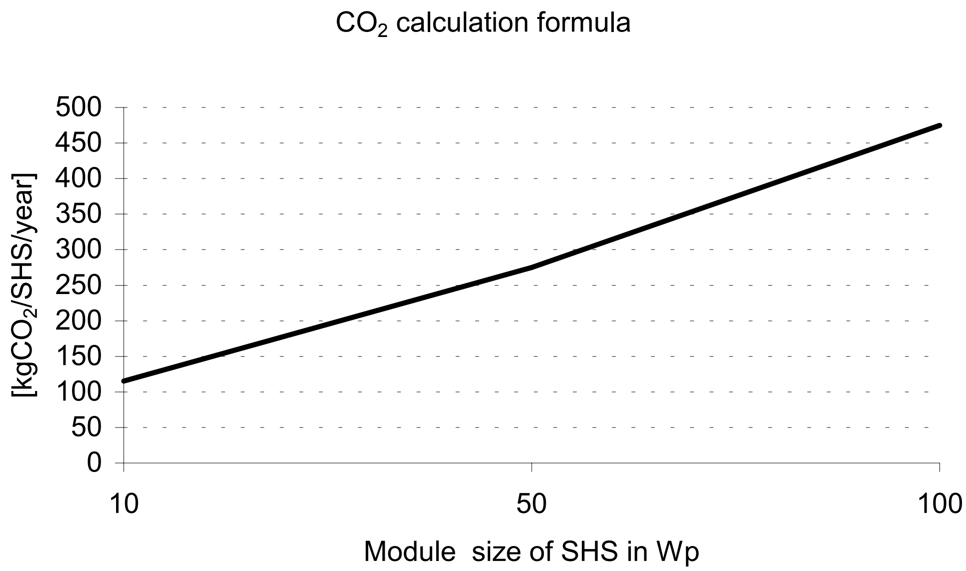

Figure 5.1 *Monitoring and Verification procedures*

Streamlined monitoring and verification procedures would need to be applied for:
- Reporting of systems deployed
- Project related monitoring of system availability
- UNFCCC monitoring of kerosene savings.

Reporting of system deployed

The most obvious way to streamline the monitoring process would be to make use of existing documents and procedures. Discussions with SHS companies revealed that most SHS companies have their financial records checked by local accountants or auditors. In a normal audit of a SHS sales company, the auditor/accountant examines the company's revenue from sales based on such documents as their customer invoices, product manufacturers' invoices, etc. Thus companies that have regular accounting audits already have the basis for verifying SHS sales for CDM purposes. With little extra action, this existing system can be used for CDM verification.

Project related monitoring of system availability
There are basically two options to streamline the monitoring of system availability. The most efficient option will be highly dependent on specific project characteristics. One option is for SHS companies to organise and conduct their own system performance monitoring. This option might especially be efficient for SHS companies that have after sales service contracts with their customers and as a result already have a method of monitoring the performance their customers' systems. This is particularly likely for companies operating under fee-for-service or which provide credit to their customers.

The second alternative is to have an independent third party implement the monitoring of the system availability. This approach might enable the reduction of transaction costs as monitoring and verification efforts could be combined. Hiring independent experts and involving the Operating Entity in the process can avoid the cost of verifying by means of household surveys. This would be cost efficient in cases where household surveys would constitute a large part of the monitoring costs.

UNFCCC monitoring of kerosene savings
We propose that an independent team of researchers conduct household surveys to gather 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 ODA, the GEF, and/or private philanthropy. The global monitoring approach would enable transaction costs to be minimised as monitoring and verification efforts would be combined.

Alternative packages of streamlining CDM procedures for Solar Home Systems
Putting the options for baseline setting together with those for project specific monitoring, 6 alternative packages of streamlined CDM procedures for SHSs (see also Table 3.1) can be identified:

- Standardised alternatives
  1. Standardised baseline based on upfront crediting and using a global emission reduction factor
  2. Standardised baseline using a global emission reduction factor and ex-post monitoring
  3. Standardised baseline using a regional or national emission reduction factor
- Project related alternatives
  4. Project baseline using a standardised factor for validation
  5. Project baseline using one baseline for all included SHS companies
  6. Project baseline using a separate baseline for each of the included SHS companies

Although option 1 would be the most streamlined and enable the greatest participation while still maintaining environmental credibility, option 2 is considered the most feasible option by the project team given that CDM rules will probably not allow for up-front crediting.

Transaction costs
The streamlined procedures appear to have a positive impact on the feasibility of SHS-CDM projects as estimates indicate that they can significantly reduce transaction costs for two example SHS-CDM projects.

Baseline standardisation and streamlined monitoring would certainly have an important impact on the costs of a SHS-CDM project. Without the proposed baseline standardisation and streamlined procedures recommended in this study:

- Project design costs could almost be three times higher
- Transaction costs could use up an extra 10% of CER revenues
- Transaction costs would account for about 20% to 40% of CER revenues, even for the large projects used as examples for illustration, and would likely overwhelm CER revenues from smaller SHS-CDM projects

Under the most streamlined option, which would include upfront crediting, transaction costs could be less than half of the costs of the least streamlined option.

Organising SHS-CDM projects

An umbrella organisation could help to organize and facilitate CDM participation for SHS market participants by providing one or more of the following services:

- Bundling SHS companies
- Co-ordinating CDM participation
- Facilitating SHS CER transactions

If one or more umbrella organisations are established to facilitate CDM transactions for SHSs and other for small-scale renewable energy applications, using the services of such entities should be optional, with project developers maintaining the ability organize their own CDM participation.

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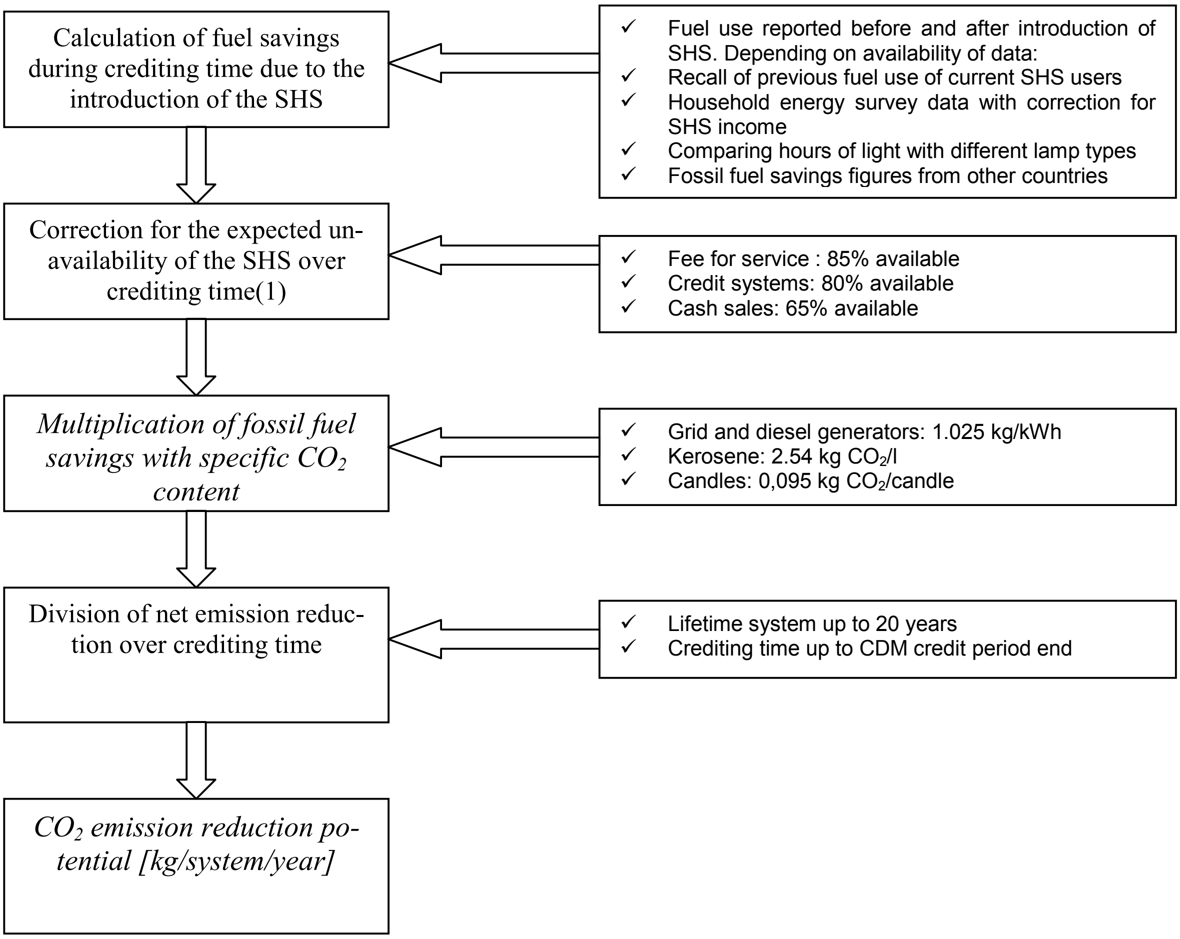
APPENDIX A PEOPLE CONSULTED DURING THE PROJECT

The project benefited from broad input from a diverse group of stakeholders and relevant experts. A steering group helped to guide the project's content and methodology and reviewed interim project documents. More than thirty experts representing a range of energy, environment, and development views provided detailed feedback regarding ideas for streamlining CDM processes for SHS activities during in depth interviews. Furthermore, numerous people supplied ideas, suggestions, and comments during telephone interviews and meetings and at project workshops held in Washington, DC and Amsterdam. The project team is grateful to all of them, too numerous to name, for sharing their time and insights.

The following tables list the names and affiliations of the people interviewed.

Name	Affiliation
Anderson, Jason	Climate Network Europe
Bilello, Dan	National Renewable Energy Laboratory (USA)
Bosi, Martina	International Energy Agency, France
Derick, Anthony	IT Power, UK
Dlamini, Sibusiso	Government of Swaziland
Duke, Richard	Princeton University, USA
Eckhart, Mike	SolarBank, USA
Ferguson, Ted	Government of Canada
Friedman, Shari	Environmental Enterprises Assistance Fund, USA
Haites, Eric	Margaree Consultants, Canada
Jacobson, Arne	Princeton University, USA
Kammen, Dan	Princeton University, USA
Kelly, Cathleen	Center for Clean Air Policy, USA
Kleiburg, Robert	Shell International, The Netherlands
Mallon, Karl	Greenpeace International
Martinot, Eric	World Bank, Global Environment Facility
Michaelowa, Axel	Hamburg University, Germany
Olivier, Anton-Louis	UNEP Collaborating Center on Energy and Environment, South Africa
Pacudan, Romeo	International Institute for Energy Conservation, the Phillipines
Rodolico, Gina	E&Co., USA
Rogers, John	Soluz Inc., USA
Salter, Liam	WWF, Brussels
Sanhueza, Eduardo	Government of Chile
Sathaye, Jayant	Lawrence Berkeley National Laboratory, USA
Spears, David	Fortum AES
Telnes, Einar	Det Norske Veritas, Norway
Thomas, J.Ph.	ENDA, Senegal
Van Aalst, Paul	Chair Dutch PV Export Group, The Netherlands
Van der Vleuten, Frank	Free Energy Europe, the Netherlands
Verschelling, Jeroen	Ecofys, The Netherlands
Wade, Herbert	Private Consultant, Thailand
Willemse, Marius	RAPS, South Africa
Winkler, Harald	Energy Research for Development Centre, Unviersity of Cape Town, South Africa
Annex-1 Expert	(not to be disclosed)

APPENDIX B CALCULATION METHODOLOGY



The correction factors for operational performance indicated in this figure were used to calculate carbon abatement in Phase I of the SHS-CDM project. The estimate of 250 kg CO_2 per average 44 Wp system on which Phase II's carbon abatement formula is based, however, assumes 100% system availability. This is because, while Phase I recommended accepting assumptions about operational performance upfront, in Phase II the project team was convinced that actual operational performance would most likely need to be monitored at the project level over time.

APPENDIX C M&V PROCEDURES FOR SHS-CDM PROJECTS

C.1 Introduction

These guidelines[10] 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[11].

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:

- Baseline methodology
- Monitoring plan
- 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.

C.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.

[10] These guidelines are separately available at: http://www.ecn.nl/unit_bs/kyoto/mechanism/cdmshs.html
[11] This paper and other relevant background material can be found on: http://www.ecn.nl/unit_bs/kyoto/mechanism/cdmshs.html

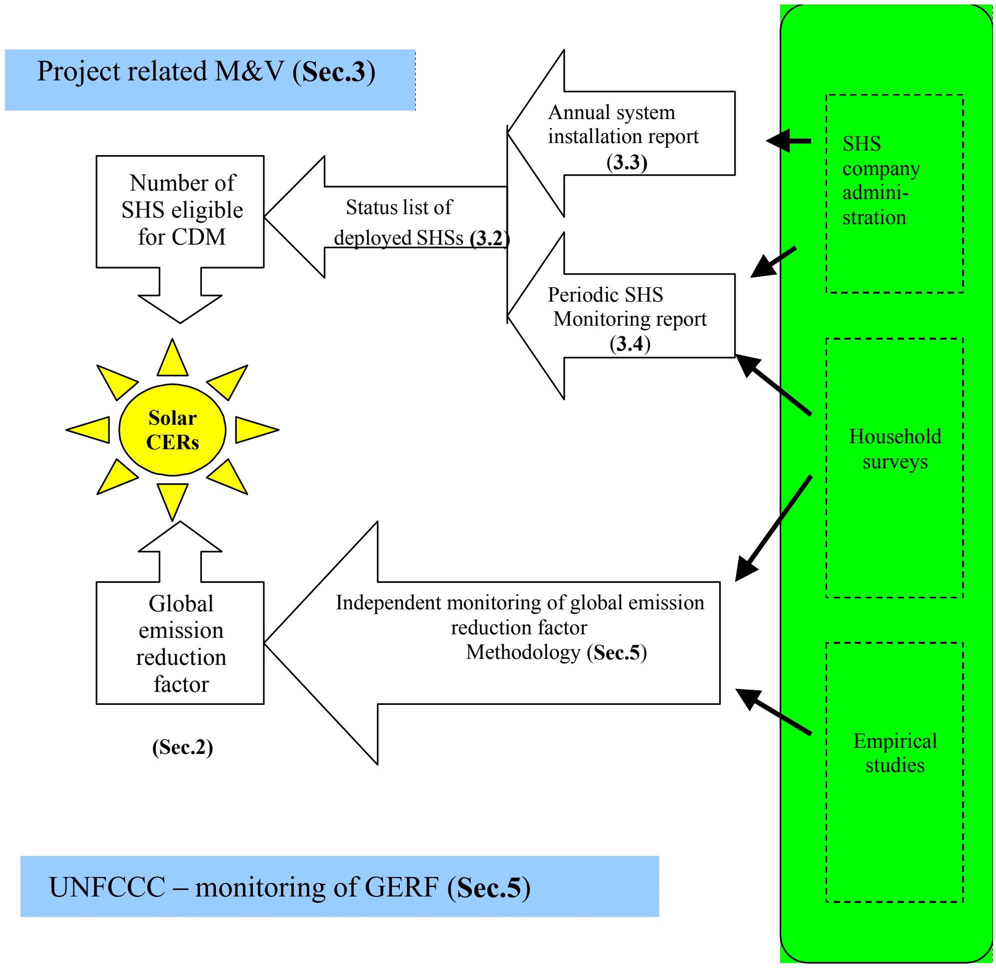


Figure C1.1 *Monitoring procedures for SHS-CDM projects*

C.2 Standardised baseline

C.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 1 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_2 calculation formula for every SHS per year is: 75 kg CO_2 per system plus 4 kg CO_2 per Wp of the module belonging to that system (see figure).

Figure C1.2 *CO_2 calculation formula*

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).[12] 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%

C.3 Monitoring procedures for SHS-CDM projects

The monitoring plan presented below 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. Similar procedures could be used for projects implemented by a single company.

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).

[12] 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.

C.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_2 per project at monitoring year X:
  Sum of individual kg CO_2 *reduction per SHS/1000*
- Individual CO_2 reduction per SHS in kg CO_2/SHS:
  (75 kg CO_2 *+ 4 kg* CO_2 *Wp* $_{SHS\ panel\ size}$*) * Uncredited operating time of SHS in years*
- Uncredited Operating Time SHS (in years) for first monitoring:
  *((X*12 + month of monitoring*[13]*) – (Y*12 + month of installation))/12.*
- Uncredited Operating Time SHS (in years) for second and further monitoring:
  *((X*12 + month of monitoring) – (year of previous monitoring*12 + 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[14]:
  *((X*12 + month of monitoring) – (Y*12 + month of installation))/12.*

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

C.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.

C.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)

[13] Fill in the number of the month, i.e. January = 1, February = 2, …, December = 12

[14] 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.

- Serial number of PV panel(s) included in SHS
- Country where system is installed
- SHS company identification number
- PV panel manufacturer(s)
- 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.

C.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_2 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.

C.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.

C.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.

C.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.

C.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.

C.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.

C.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.