



Carbon Finance
AT THE WORLD BANK

Promoting Energy Access Projects
under the Clean Development Mechanism

STANDARDIZED BASELINES AND SUPPRESSED DEMAND

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New concepts under the Clean Development Mechanism (CDM), namely standardized baselines and suppressed demand, should facilitate the implementation of CDM energy access projects, particularly in Least Developed Countries (LDCs), by reducing transaction costs and reflecting the real emission reductions achieved. Governments and authorities in LDCs can play a prominent role in making these new CDM opportunities available. The improvement of the regulatory framework can facilitate the development of innovative carbon-based financing schemes required for successful scaling-up of CDM energy access projects in LDCs.

This paper is part of a work program on technical aspects of CDM regulation and project cycle improvement started by the World Bank in May 2011 at Carbon Expo in Barcelona. This work benefited from intensive consultations with representatives from developing countries' Designated National Authorities and from Annex I countries, practitioners, and experts on the CDM during two workshops held in 2011. The paper was prepared by a team from the Carbon Finance Unit of the Climate Policy and Finance Department of the World Bank, consisting of Harikumar Gadde (lead author), Affouda Leon Biauou, Alexandrina Platonova-Oquab, Julie Godin and Klaus Oppermann. Financial support was provided by the CDCF Technical Assistance Trust Fund, the technical assistance fund associated with the Community Development Carbon Fund and funded by contributions from the governments of Canada, Italy, Spain, and of the Walloon Region of Belgium, as well as the United Nations Environment Programme (UNEP).

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1.0 Introduction

About one in five people in least developed countries (LDCs) lack access to electricity.¹ High dependence on traditional fuels like fuel wood for cooking and heating and kerosene for lighting contributes to unsustainable living conditions and greenhouse gas (GHG) emissions. In order to achieve universal access to energy by 2030—one of the United Nation’s Sustainable Energy for All Goals—LDCs need to scale up investments in the energy sector. Carbon crediting under the Clean Development Mechanism (CDM) as well as other standards can support these investments by providing an additional stream of revenues, both at the time of the initial investment and in the operational phase, and make these investments sustainable. The economics of carbon crediting are favorable to energy access projects such as rural electrification or improved cook stoves. However, only a few of these projects have been implemented so far under the CDM in LDCs. This paper argues that new developments in CDM regulation, in particular using standardized baselines and taking into account suppressed demand, can accelerate the development and implementation of energy access projects in LDCs, provided their operationalization is simplified and enhanced.² Other major building blocks in this context are the establishment of a positive list approach to additionality demonstration for micro-scale project activities and the development of top-down methodologies.

However, an improved CDM is in itself not sufficient to promote energy access projects on a larger scale. It has to be accompanied by innovative financial solutions that allow for the front-loading of carbon revenues. It also relies on the host country governments and Designated National Authorities (DNAs) to take on a more prominent role, something that is already anticipated in the new CDM concepts.

The main purpose of this paper is to outline how the new CDM concepts of standardized baselines and suppressed demand may be used to promote energy access projects under the CDM, in the context of new and expanded role of host country DNAs. In the process, the paper also identifies challenges in the use of these concepts and opportunities for further simplification. By way of illustration, one specific energy access technology, solar home systems, is analyzed in detail. The paper is organized as follows: Chapter 2 provides an overview of the current status of CDM projects in LDCs; Chapter 3 introduces energy access projects in LDCs; Chapter 4 outlines new approaches under the CDM for energy access projects; Chapter 5 goes into the challenges for the application of standardized baselines in LDCs; and Chapter 6 gives recommendations on implementing the new CDM concepts.

¹ WEO 2011, UNDP, the World Bank

² For more on this, refer to the recent World Bank report entitled “CDM Reform: Improving the efficiency and outreach of the Clean Development Mechanism through standardization.”

2.0 CDM projects in LDCs – status update

To date, low-income regions with low energy access make little use of carbon finance mechanisms for leveraging investments in the household energy sector. As of February 1, 2013, least developed countries (LDC)³ only hosted 1.2 percent of all CDM projects worldwide⁴. Only 35 of all currently registered CDM projects⁵ (that is, 0.6 percent of the total number of CDM projects) target increased or improved energy access for households and of these, fourteen are located in LDCs. These 14 projects have the potential to reduce emissions by up to 0.5 million tons of CO₂e per year⁶ but to date less than 3,000 tCO₂e emission reductions have been verified and issued.

Though the share of stand-alone CDM projects³ in LDCs, is very low, the share of programmes of activities (PoAs)³ is higher (11 percent⁷). Many of the PoAs in these countries target enhanced and higher-quality energy access. As of February 1, 2013, there were more than 42 PoAs from LDCs in the CDM pipeline, mostly targeting energy access projects, as illustrated in Table 1 below

Table 1: Types of PoAs targeting energy access in LDCs

Host country	Type of PoAs
Bangladesh	Solar PV, EE households stoves, households lighting
Rwanda	EE households stoves
Senegal	Households lighting
Tanzania	Solar lamps, micro hydro for off-grids
Togo	EE household stoves
Nepal, Zambia, East & West Africa	Cook stoves

Research suggests Sub-Saharan Africa could develop more than 3,000 CDM projects, which could reduce GHG emissions by approximately 10 billion tons over a crediting period of 10 years⁸ (World Bank, 2009). The realization of this CDM potential could significantly enhance sustainable development in the region, as it would attract more than \$200 billion in investment and could generate annual carbon revenues in the range of \$5–10 billion (based on a carbon price of \$5–10 per tCO₂e). In comparison, the annual official developmental assistance (ODA) committed to Sub-Saharan Africa (including South Africa) during 2010 amounted to \$48 billion.⁹

³ LDCs included are Haiti, Bangladesh, Bhutan, Cambodia, Lao PDR, Myanmar, Nepal, Angola, Burkina Faso, Burundi, Chad, Congo DR, Equatorial Guinea, Ethiopia, Lesotho, Liberia, Madagascar, Malawi, Mali, Mozambique, Niger, Rwanda, Senegal, Sierra Leone, Sudan, United Republic of Tanzania, Togo, Uganda and Zambia

⁴ Including projects under validation, requesting registration, and registered

⁵ Projects and programs (POA) using methodologies AMS-I.A., AMS-I.E., AMS-I.F., AMS-I.L., AMS-II.G, AMS-III.AR, and AMS-III.AW

⁶ For PoAs, only CPAs included during registration are considered.

⁷ Source: UNFCCC website, UNEP RISOE database

⁸ A recent study commissioned by the German Federal Ministry for the Environment (BMU) identifies a technical abatement potential of 10.7 million tCO₂e from cook stove projects alone, in 11 selected LDCs in Sub-Saharan Africa.

⁹ Data for year 2010; source: OECD - http://stats.oecd.org/Index.aspx?DataSetCode=AEO11_OVERVIEW_CHAPTER2_FIG1_EN

Despite the low uptake of CDM projects in LDCs so far, consensus is building on the important role that carbon finance can play in supporting the development agenda in poor countries. While Africa has not benefited much from the CDM during the first commitment period of the Kyoto Protocol, interest has been growing recently in using the CDM to deliver results-based financing for mitigation and development projects. New generation instruments such as the World Bank's Carbon Initiative for Development (CiDev) are designed to support a portfolio of CDM programs in the energy sector in Africa by purchasing and retiring the credits they will generate, in effect piloting an innovative approach to results-based financing for energy access. These approaches do not rely on existing carbon markets as they do not depend on demand for carbon credits from mitigation targets in industrialized countries. In fact they are moving away from offsetting into climate finance. Applying a logic of results-based finance to the CDM enables to rethink and to reposition the mechanism but also shows the urgent need for further and more far reaching CDM reform efforts including on simplifying the CDM project cycle.

3.0 Energy access projects in LDCs

There are, generally speaking, two common types of energy access projects in LDCs—one that aims to increase rural electricity supply and another one that aims to improve cooking facilities. Rural electrification is usually achieved through (i) the installation of systems such as solar home systems and solar lanterns (off-grid electrification); (ii) the development of mini and isolated grids by using diesel generators, micro hydro plants, biomass plants, solar photo-voltaic systems, and the like; and (iii) the extension of the main grid to areas that are close to grid-connected areas. Cooking facilities are improved by providing efficient cook stoves, bio-digesters, and LPG stoves.

For rural electrification projects in off-grid areas, fossil fuel consumption is reduced primarily by replacing fuel-based lighting with lighting that adopts new technologies like solar lanterns, PV based systems, LEDs etc. For cook stove projects, improved combustion reduces fuel consumption and thereby also reduces GHG emissions.

The high initial up-front costs associated with the deployment of these systems may be offset to some extent by carbon revenues. A rough estimate of carbon finance potential reveals that the installation of the most commonly used solar home system of 40–50 Wp capacity in a household (costing around \$500) can yield carbon revenues of \$0.5–5 per year,¹⁰ while the installation of an improved cook stove (costing \$20–50) can earn up to \$10–20 per year. Carbon revenues cover a larger portion of the total costs of purchase and operation of cook stoves projects than solar home or grid extension projects, mainly because of the high upfront costs involved and varying degree of carbon reduction potential due to uncertainty with baseline establishment. The rural energy access projects are also expected to result in considerable co-benefits in terms of improved health, reduced indoor air pollution, and reduced forest degradation, to name just a few. More importantly, these projects also expected to result in black carbon emission reductions which are considered to be one of the largest contributor of the climate change, next to carbon dioxide emissions.

In the case of rural electrification projects, the quantification of emission reductions is generally based on historical baseline consumption (or reference) levels, which are low but do not take into account the minimum level of consumption that is necessary for meeting basic human needs—a situation known as suppressed demand. Estimation of emission reductions based on such low and inadequate reference levels results in low emission reductions. In addition, the grid emission factor in many LDCs is low due to the

Box 1. What is suppressed demand?

Suppressed demand arises when the actual demand of user groups (mostly households) is insufficient to meet their basic human needs due to low income (income effect), inadequate infrastructure, the high costs of technology, or a combination of these. In many LDCs, household consumption is constrained by these factors and, as a result, their basic human needs go unmet. As the situation improves, for example, incomes start rising, consumption levels are likely to go up as well and over time basic human needs will be duly met. Moreover, as technology costs go down and energy efficiency goes up, households may start using more services (rebound effect). At present there are no accurate methods to estimate suppressed demand or define basic (that is, minimum) human needs or levels for services such as lighting and cooking.

¹⁰ Assuming a carbon saving potential of 0.1 to 0.5 tCO₂ per year, depending on the amount of kerosene fuel saved.

relatively high share of renewable energy-based generation.

Suppressed demand (see box 1), a feature highly relevant and applicable to projects targeting improved energy access in low-income countries, is not yet duly recognized and covered under the present CDM methodologies and guidelines. Yet following the recent approval of suppressed demand guidelines, a few CDM methodologies have attempted to address this shortcoming. Unfortunately, they still fail to properly take into account achievable emissions reductions, mainly because of the lack of data for establishing baselines.

Box 2. What is a standardized baseline?

Standardized baseline allows setting a baseline that is not necessarily specific to one type of project activity, but can be applicable to most of the possible project activities in a sector. Also, additionality does not have to be demonstrated for each individual project activity ex-post (after its formulation) but rather for specific types of measures and ex-ante. For example, for off-grid electrification projects, this approach allows to set a baseline, say for lighting service, at the sector level and identify specific technology(ies)/measures that provide services and can automatically be considered additional.

In addition, many of the existing methodologies that target increased or improved energy access require extensive data to establish baselines, and data monitoring costs are high. The recent approval of standardized baseline guidelines¹¹ (see box 2) by the CDM EB makes it easier to set baselines and determine the additionality for these project types by doing so ex-ante at the sector rather than the project level. Though these guidelines are expected to simplify the process, further improvements are possible and necessary, especially regarding monitoring requirements.

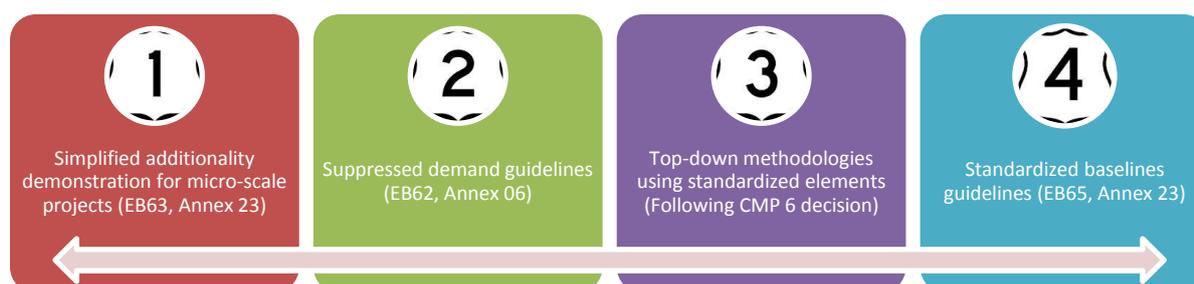
Standardization can also be achieved through other methods, for example, using performance benchmarks, that is, default values fed directly into the CDM methodologies.

¹¹ http://cdm.unfccc.int/Reference/Guidclarif/meth/meth_guid42.pdf

4.0 New approaches under the CDM for energy access projects in LDCs

Considering the low uptake of CDM projects in LDCs and the high transaction costs of disbursed project activities like solar home systems and cook stoves projects, the CDM Executive Board (EB) has embarked on some major initiatives during the last 2 years to address the shortcomings of existing CDM methodologies. To date, four major initiatives have been implemented (see figure 1).

Figure 1: Major initiatives taken by CDM EB



1. Simplified additionality rules

Under the simplified additionality rules for micro-scale project activities,¹² the projects are automatically considered additional if the activities are implemented in LDCs or SIDS and/or target households and communities and meet certain thresholds for each system/activity being deployed/implemented. Table 2 lists the requirements to be met for various project types under these rules to qualify for automatic additionality.

Table 2: Simplified additionality rules for various project types in LDCs and small island developing countries

	Renewable Energy	Energy Efficiency	Others (like waste management, transport)
Target group and individual system requirements	<ul style="list-style-type: none"> - Off grid: Households/communities - Distributed systems: Households / communities/SMEs and systems capacity <=1500 kW - Uses specific renewable energy technologies / measures recommended by host countries 	Households/communities / SMEs and reduces less than or equal to 600 MWh savings	Households/communities/ SMEs and reduces less than or equal to 600 tCO ₂ savings

¹² Up to 5 MW for renewable energy projects, up to 20 GWh annual energy savings for energy efficiency projects, and up to 20 kt tCO₂ per year for other project activities

2. Suppressed demand guidelines

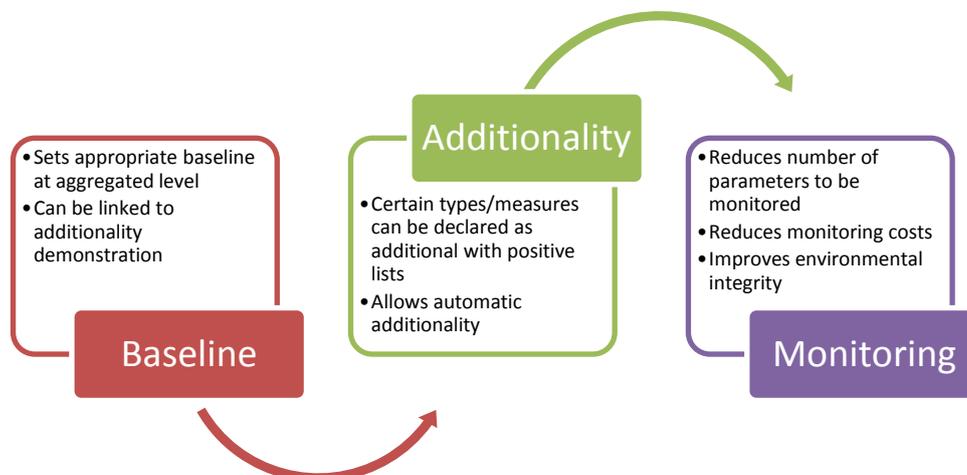
The approval of the suppressed demand guidelines recognizes a baseline scenario where future emissions by sources are projected to rise above current levels, due to the specific circumstances of the host party. They are applicable when the service level that was available to the end user of the service prior to the implementation of the project activity was too low to meet basic human needs. The application of these guidelines is expected to help with the identification of the baseline technology/measure under a suppressed demand scenario and of a baseline service level to be used to calculate baseline emissions. The guidelines allow for three ways of identifying baseline service levels, depending on the type of project activity: (i) based on services provided prior to project activity; (ii) based on services provided during the project activity, and (iii) based on minimum service levels identified.

The identification of a minimum service level needs to ensure that it meets the basic human needs and makes possible the development of the type of project at hand. However, financial viability alone cannot be the deciding factor in determining the minimum service level, as this might compromise environmental integrity. An approach that allows the selection of a service level that is higher than the one provided prior to the implementation of the project (as it takes into account the income and rebound effect) but entails an increase in baseline emissions, may provide an opportunity for technological leapfrogging to a low emission path and clean development.

3. Standardized baselines

The establishment of standardized baselines is expected to improve CDM efficiency since determining the baseline and demonstrating additionality are often among the most complex phases of the CDM project cycle. Standardized baselines have the potential to increase the objectivity of assessment and validation, and simplify data gathering at the project level. In addition, several benefits are expected, including the reduction of transaction costs, increased transparency, better predictability of emission reductions, and potentially scaling up of the abatement of GHG emissions in underrepresented sectors and countries.

Figure 2: Expected benefits of standardization



Several approaches have been identified for standardization. These include the identification and definition of criteria, the setting of reference values, and the selection of parameters considered representative and applicable for a pre-defined population of project activities.¹³

Currently, standardization of baselines and additionality can be achieved through two paths:

- (i) **Path # 1:** By introducing *standardized elements* into the development of new technologies or the revision of approved methodologies; examples of this are approved methodologies such as AM0070: *Manufacturing of energy efficient domestic refrigerators*, AM0091: *Energy efficiency technologies and fuel switching in new buildings*, and AMS-III.AV.: *Low greenhouse gas emitting water purification systems*.
- (ii) **Path # 2:** By following the UNFCCC *Guidelines on standardization*¹⁴ for the ex-ante identification at the country or regional level of technologies/measures that are additional and of baseline technologies with the corresponding emission factor. No approved standardized baselines under this path existed as of February 1, 2013.

Standardization based on the introduction of standardized elements (path # 1) can be achieved through:

- Positive and/or negative lists (used for additionality demonstration)
- Penetration levels (used for baseline setting and/or additionality demonstration)
- Performance standards or benchmarks (used for baseline setting and/or additionality demonstration)
- Deemed or default values (could be used for simplified monitoring)

The main characteristics of these approaches are presented in figure 3.

¹³ Adapted from Table 6 in AEA (2011). Study on the Integrity of the Clean Development Mechanism. Commissioned by the European Commission and carried out by a consortium of AEA, the Stockholm Environmental Institute, the Centre for European Policy studies (CEPS), and CO2logic under the lead of AEA.

¹⁴ [Guidelines for the establishment of sector specific standardized baselines](#)

Figure 3: Different standardization approaches



Following CMP 6 decision, the CDM EB also initiated the development of standardized approaches by “*prioritizing methodologies that are applicable to least developed countries (LDCs), small island developing states (SIDS), Parties with 10 or fewer registered CDM project activities as of 31 December 2010 and underrepresented project activity types or regions, inter alia, for energy generation in isolated systems, transport and agriculture*” under standard top-down approach. This work is to be done in consultation with DNAs. Some of the methodologies approved by the EB to date are AMS-I.J.: *Solar water heating systems (SWH)* and AMS-III.AR.: *Substituting fossil fuel based lighting with LED/CFL lighting systems*.

Which path to choose for standardization depends on several important aspects such as:

- Country CDM strategy
- Potential in the sector
- Measure/technology under consideration
- Expected relative change in emission reduction volumes
- Data availability and ease of access
- Time required for development and approval
- Existing development capacity (institutional and technical)

DNAs and project developers will base their choice on an assessment of the merits associated with each path.

Standardization for rural energy access projects

In the case of improved energy access projects, standardization coupled with suppressed demand considerations has the potential to: (i) improve the accuracy of baseline establishment; (ii) increase the volume of claimable emission reductions; and (iii) reduce monitoring costs.

Table 3 compares the two paths of standardization for increasing electricity access¹⁵ through the use of solar home systems (off-grid electrification; refer to annex II for a detailed analysis). Standardization under path # 1 is demonstrated through the recently approved methodology AMS-I.L.: *Electrification of rural communities using renewable energy*, developed by the World Bank. Under this approach, the baseline technology and the fuel used for each category of household application (such as lighting and other household appliances) are pre-established, based on a specific minimum service level (that is, 250 KWh; please refer to annex 1 for details on how the minimum service level for household electricity consumption was established). Depending on the electricity use (or consumption) of each household in a project scenario, a tiered “default” emission factor is established.

Figure 4: Comparison of the two paths for standardization

Parameter	Path # 1: Using standardized elements in to methodologies	Path # 2: Using UNFCCC guidelines on standardized baselines
Applicability	Global	Country-specific
Owner	Public good	Country-specific (respective DNA ¹⁶)
Standardization approach	Using default values	Following UNFCCC guidelines
Data needs for development and its approval	Low	High (initially)
Additionality	Can be eligible to use the micro-scale guidelines	Identified technology will become part of a positive list and hence automatically additional at the project level
Baseline identification	Needs to use global data and allows use of more default data	Needs to use country-specific data and data collection is required for the “output” of the selected technology/service provided
Suppressed demand considerations	Possible using suppressed demand guidelines but the minimum service level value identified will be common to all countries	Possible using suppressed demand guidelines but no clear guidance on how to take this into account in the guidelines; the minimum service level value identified will be specific to the country

¹⁵ Similar analyses may be done for projects targeting increased energy access through the use of improved cook stoves, bio-digesters, etc.

¹⁶ Designated National Authority

Parameter	Path # 1: Using standardized elements in to methodologies	Path # 2: Using UNFCCC guidelines on standardized baselines
Emission reduction potential	Higher compared to methodologies without suppressed demand accounting; depends on a minimum service level considered at a global level	Higher compared to methodologies without suppressed demand accounting; depends on a minimum service level set a country level
Monitoring	Simplified, as it requires only the monitoring of the number of systems in operation	Simplified, as it requires only the monitoring of the number of systems in operation
Costs for development (relative)	Low	High
Capacity needed (relative)	Low	High (and remain to be tested)
Approval procedure	Developed and submitted by project entity and approved by the Small-scale working group and finally by the CDM Executive Board	Developed by either project entity or any international organization or DNA; submitted by DNA to the CDM Executive Board for its approval

Monitoring and standardization

Simplification of baseline identification and the use of more default values through standardization are expected to reduce the number of parameters that have to be monitored ex-post. The standardization approach and its impact on monitoring are expected to vary with the type of technology and measure selected. A few existing methodologies already benefit from simplified monitoring requirements by allowing a certain degree of standardization (for example, AMS-I.A: Electricity generation by the user). Standardization of a few important ex-post monitoring parameter values is expected to significantly lower monitoring costs. For example, standardization of the “availability factor” of the solar home systems should reduce monitoring costs by not having to measure the electricity generation of each system. The same goes for the standardization of household level electricity consumption in relation to income levels and usage patterns. The recognition of opportunities for simplified monitoring and verification under standardized baseline approaches based on guidelines should encourage the development of more standardized baselines.

In view of the above, if DNAs and/or project developers have to choose a path, the decision matrix presented below may help in the selection process (although the ideal path will depend on the type of technology/measure and overall merits of each path chosen).

Path # 1: Methodology path:



Path # 2: UNFCCC standardized baseline guidelines path:



The establishment of standardized baselines following UNFCCC guidelines, which requires host country DNA to submit to CDM EB, would make it easier to set baselines and determine additionality for a select number of measures/technologies in a given country (valid for 3 years, under current guidelines). In this way, all projects from that specific country would benefit from lower data collection costs in terms of time and money. However, the associated maintenance aspects, such as the need to update the data once every 3 years and budget more financial resources, also have to be taken into account when deciding on the best path for achieving the standardization.

5.0 Challenges in the application of standardized baseline guidelines for rural energy access projects

Despite the advantages deriving from the identification of customized standardization and country-specific circumstances, the application of guidelines to rural energy access projects faces challenges. The main challenges foreseen (as this approach is yet to be tested) are the following:

- **Duly taking into account suppressed demand:** The standardized baseline guidelines do not provide enough guidance and clarification on how suppressed demand needs to be accounted for while identifying the baseline technology and emission factor. Identification of baseline technology and emission factor might be completely different in a scenario without proper suppressed demand accounting.
- **Considering differences in the service quality:** The guidelines only specify how to consider the output in the sector and identify the corresponding technologies and fuels but fail to specify clearly how to determine the service quality of the output for consideration. As there will always be several technologies/fuels available to provide a given *output* (for example, heating for cooking), selection and differentiation of technologies based on the *quality* of output provided would narrow down the list of technologies (for example, this may eliminate LPG stove from the list for heating).
- **Quantification of barriers:** The guidelines provide little guidance on how to objectively quantify barriers that the identified technologies face and whether they can be applied in technologies/measures in rural energy projects to eliminate technologies that are commercially unattractive. If cost is the principal and sole consideration for elimination of certain technologies from the list, it is not clear how the impact of existing policy incentives is to be taken into account, especially if such policy intervention is costly but makes the technology itself cheaper. More important, focusing on capital or levelized cost analysis of technologies for additionality demonstration completely ignores the practical difficulties and barriers that exist for the implementation of certain technologies in poorer countries.
- **Use of sector-specific values:** Considering the very diverse range of activities and the very limited availability of data in any sector (in most countries), the establishment of a baseline emission factor based on country-specific information may be too costly as it involves huge data gathering requirements. Moreover, the collection of data in line with the quality assurance/quality control guidelines set by the EB appears to be very labor-intensive and costly.
- **Data vintage and update frequency:** Standardized baseline guidelines require updates every 3 years for all relevant parameters used in the development of the standardized baselines. A period of 3 years may be considered short, compared to the effort needed to establish standardized baselines; the effort is a data-intensive process that requires funding, and might become a barrier to the development of standardized baselines, particularly for LDCs. Furthermore, application of any updates to the baseline for already registered projects before their crediting period renewal could affect the predictability of carbon revenues..

- **Unpredictable project cycle and regulatory procedures:** Apart from the technical difficulties, there are challenges and limitations related to the current regulatory and procedural gaps for projects that are eligible for the use of sector-specific standardized baselines. Lengthy registration cycles for projects with relatively short implementation timeframes, such as energy access projects, provide a disincentive for project developers as they have to forego carbon revenues in the period from the implementation date to the registration date. These issues could be addressed more effectively by creating more certain, predictable, and standardized project cycles.¹⁷

¹⁷ For more on this point, refer to the recent World Bank report entitled “CDM Reform: Improving the efficiency and outreach of the Clean Development Mechanism through standardization.”

6.0 Recommendations

Considering challenges foreseen with development of standardized baseline guidelines for rural energy access projects, the following recommendations are made for their improvement and easy operationalization:

- **Allow the use of more default values:** As the experience in LDCs shows data availability is often a problem. It would therefore be useful to propose default values for various common parameters that could be applied globally. Should a country DNA choose to use these default values, these data could be used for all facilities that utilize standardized baselines. The adoption of materiality standards in the application of this guidance would be useful.
- **Recognize the use of data already available—both nationally and internationally:** Considering the difficulties inherent in collecting facility-specific and user-specific data, the guidance document should accept the use of existing data that have been collected for other purposes, for instance, through household surveys. In addition, allow the use of secondary data collected by relevant national institutes or government agencies for various purposes in addition to country-specific data published by the International Energy Agency (IEA), the Food and Agricultural Organization (FAO), etc.
- **Be flexible as far as data vintage and update frequency goes:** As pointed out earlier, a mandatory update every 3 years may be especially costly in the context of LDCs. A preferred approach would be to allow cross-checking of data every 3 years, based on a relevant indicator such as market penetration with a pre-defined threshold, and update after 5 years only if it falls below that threshold.
- **Guidance on minimum service levels:** Whenever information on minimum service levels is not available or varying minimum service levels are reported, a procedure for defining default values for minimum service levels by DNAs and communication to the UNFCCC needs to be specified to avoid variations on the minimum service levels identified by the project developers. Guidelines need to be defined on the procedure for requesting the revision of a minimum service level approved by DNA or EB for situations in which the approved minimum service level is not relevant to the project/program contexts.
- **Allow the use of service quality as a criterion:** Guidance on how to recognize the quality of service needed and provided would help the developer narrow down the list of relevant technologies/measures and thus reduce the amount of data and data analysis needed. This would also help identify the technologies that are substitutable while eliminating the technologies that are too costly.

7.0 Conclusion

More options are now available to standardize the way baselines are established and additionality is demonstrated for projects and PoAs under the CDM, in a way that could reduce transaction costs and increase predictability. DNAs have the prerogative to submit standardized baselines that define additionality as well as baseline emissions for specific sectors suited to their country's circumstances. DNAs have been given a much more important role in order to enhance the regional distribution of CDM projects; they have a major role to play in the establishment of sector-specific, standardized baselines that take into account their national circumstances so as to promote the taking-up of CDM projects. In addition, development of standardized baselines could simplify the CDM project cycle procedures and hence reduced transaction costs, increased predictability and efficiency. Setting standardized baselines at the national level in priority sectors could provide important incentives for transitioning to low carbon development. Coordination among government agencies in identifying the priority sectors and collecting data is also likely to be an important element of the implementation. Given the pragmatic nature of the approach and its sectoral implications, the implementation of this concept could represent a bridge as well as a learning opportunity toward new market mechanisms. Implementation could be linked to government priorities to create incentives for low carbon development in key sectors. However, whether to opt for the use of the *Guidelines* to establish sector-specific standardized baselines or a use of standardized elements in to a methodology will depend on different factors, among other things the potential for GHG emission reductions at the national level, and the availability of data and resources.

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UNFCCC 2011. *Guidelines on the consideration of suppressed demand in CDM methodologies* (http://cdm.unfccc.int/Reference/Guidclarif/meth/meth_guid41.pdf).

Annex I: How minimum service level is established for household electricity consumption

The most prominent source for a minimum service level related to household electricity consumption is the work of the International Energy Agency (IEA), UNPD, and UNIDO on the amount of energy required to eliminate energy poverty worldwide by 2030 (IEA 2010). The analysis of electricity requirements states:

“To assess the extent of the additional generating capacity required to achieve universal access, we have made assumptions about minimum levels of consumption at both the rural and urban level: rural households are assumed to consume at least 250 kWh per year and urban households 500 kWh per year. In rural areas, this level of consumption could provide for the use, for example, of a floor fan, two compact fluorescent light bulbs and a radio for about five hours per day. In urban areas, consumption could also include a television and another appliance, such as an efficient refrigerator or a computer. Consumption is assumed to rise every year until reaching the average national level.” (IEA 2010)

Note that while the latest analysis gives a floor fan, CFLs and a radio as an example, other combinations of appliances are also possible (see the reference to the IEA study above).

This most recent analysis of basic energy needs follows a similar analysis and values presented in earlier IEA and United Nations reports (AGECC 2010; IEA 2009).¹⁸ This value for household electricity consumption is even less than the “subsistence household consumption” used in the Africa Infrastructure Country Diagnostic (Banerjee et al. 2008),¹⁹ and is only a third of the medium estimate of rural electricity consumption cited in a study by researchers from UNIDO, IAEA, and KTH (Bazilian, Nussbaumer, Haites et al. 2010).²⁰ By way of comparison, Table A1 gives rural electricity consumption data for a variety of countries, almost all higher than 250 kWh per household, suggesting that this is a conservative default factor. The methodology therefore sets the minimum service level for overall household electricity services at 250 kWh per household per year, and then distributes this among lighting and other purposes.

¹⁸ The IEA World Energy Outlook 2009 (p. 132) “universal energy access case” is based on 50 kWh per person per year in rural areas and 100 kWh per year in urban areas. Assuming an average household size of 5 people, annual energy consumption per rural household would amount to 250 kWh. The AGECC report (p. 9) refers to an on-going UN Energy analysis and states that the lowest values considered are 100 kWh per person per year. The AGECC report refers to this electricity as being for “lighting, health, education, communication and community services” but does not specify the shares of these services. The IEA 2009 analysis specifies neither the end uses nor the shares of those end uses.

¹⁹ This study used 300–600 kWh per household per year.

²⁰ To calculate the energy and investment requirements for universal energy access, this study uses the IEA numbers as the “low scenario” and three times those consumption values for the “medium scenario.”

Table A 1: Selected values for electricity consumption in rural households

Country	Consumption (kWh/ household)	Source	Comment
Indonesia	540	(IEG 2008, p.33)	Rural households
Lao PDR	504	(IEG 2008, p. 33-4)	Rural households
Philippines	768	(IEG 2008, p.33-4)	Rural households
Ethiopia	228	(IED 2006, p.56)	Urban areas – rural expected to be lower
Bangladesh	312	(Barnes, Peskin, and Fitzgerald 2003)	Rural households
Bangladesh	420	(Khandker, Barnes, and Samad 2009)	Rural households electrified 5 years or less
Vietnam <2 yrs	432	(Khandker et al. 2009)	Rural households electrified less than 2 years
Peru	324	(Meier et al. 2010)	
Kenya	360	(Parshall et al. 2009)	Spare (that is, rural), poor areas
Yemen	240	(Wilson, Jones, and Audinet 2011)	Lighting only: Weighted average of all electrified households, rural and urban
Cambodia	333	(UNDP 2008)	Rural, grid-connected households
Cambodia	247	(UNDP 2008)	Rural, mini-grid connected households

Annex II: Standardization for rural energy access projects

The following section discusses how the standardization is achieved for baseline establishment, additionality demonstration, and baseline emission factor determination for the methodology that is applicable for solar home systems using the two paths discussed above.

Methodology AMS-I.A.: Electricity generation by the user

Existing small-scale methodology AMS-I.A.: Electricity generation by the user is selected for a base-case scenario to demonstrate how standardization can be achieved. Despite its approval back in 2004, only three projects²¹ have been registered to date that use this methodology for rural electrification applications.

Baseline and its emission factor

The baseline and its emission factor under AMS-I.A.²² is based on fuel consumption of the technology in use or that would have been used in the absence of the project activity to generate the equivalent quantity of energy using any of the following three options, based on the results of direct metering or on a performance comparison of the peer group:

- Direct metering (*Option #1*): Based on the estimated or metered average annual individual energy consumption observed in similar systems;
- Comparison of performance with a peer group (*Option #2*): Based on the estimated annual output of the group of renewable energy technologies installed;
- Historical level (*Option #3*): Based on trend-adjusted projection of historic fuel consumption.

The establishment of baselines using the above options requires large volumes of data that are difficult to get. Moreover, the approach suggested yields low emission reduction volumes due to the fact that suppressed demand is not properly taken into account.

Additionality demonstration

As the individual systems have a capacity of less than 1500 kW, and are used for household or community applications, primarily in LDCs, a simplified additionality criterion for micro-scale project activities can be applied for the demonstration of additionality. Consequently, these systems are most likely automatically deemed additional.

a) Standardization under path # 1 (as evidenced in the new methodology AMS-I.L.)

The potential for standardization of off-grid electrification projects using technologies such as solar home systems based on methodological improvements (Path # 1) that take into account suppressed demand can be illustrated with a new (alternative) methodology for off-grid rural electrification submitted by the World Bank to the Small-scale working group and approved by the CDM EB in

²¹ <http://cdm.unfccc.int/Projects/projsearch.html>

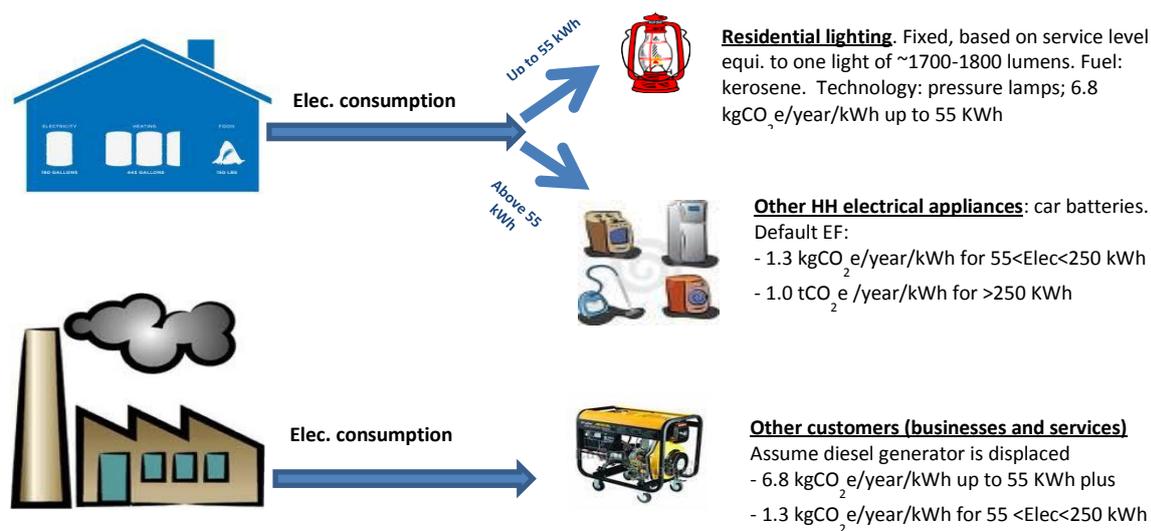
²² At the time of writing this section, SSC-WG is working on improving this methodology to account suppressed demand

March 2012 as methodology AMS-I.L.: *Electrification of rural communities using renewable energy* (EB65, Annex 53).

Baseline and its emission factor

Figure A1 illustrates how standardization of the approved methodology AMS-I.A.: *Electricity generation by the user* can be achieved (in the case of solar home systems) following Path # 1 as approved under AMS-I.L.

Figure A 1: Baseline and emission factor under Path # 1



Under this approach, for each category of household application (that is, lighting, household appliances), a baseline technology and fuel used are pre-established for their respective electricity consumption based on the minimum service level identified for the household (that is, 250 kWh; refer to Annex 1 for details on the establishment of the minimum service level for household electricity consumption). Depending on the electricity use (or consumption) of each household, a tiered default emission factor is established so that no data will have to be collected for baseline establishment other than the system capacity and its availability factor (for systems with a capacity of less than 1 kW).

Additionality demonstration

As in the case of methodology AMS-I.A., these systems will automatically be deemed additional given their size (< 1500 kW), application (household/communities), and project location (LDCs).

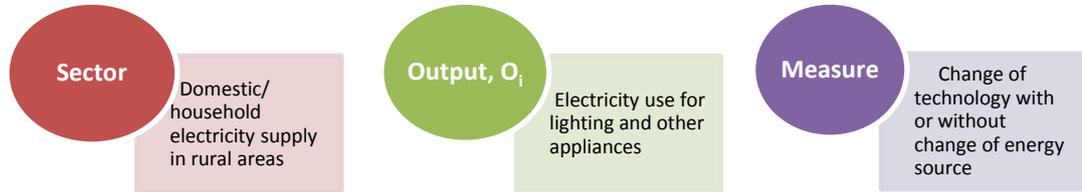
b) Standardization using newly approved standardized baseline guidelines (Path # 2)

The standardization achieved through the above methodology path is applicable to similar projects implemented anywhere on the globe. However, if one wants “customized standardization,” one that takes into account and reflects country-specific circumstances and could bring potential benefits in terms of identification of country-specific technologies/measures that will automatically be additional and duly accounted for in their emission reductions, this can be achieved by following the

guidelines recently approved for standardization by the CDM EB. The recently approved standardized baseline procedures propose the following stepwise procedure for the establishment of baselines, the demonstration of additionality, and the determination of the emission factor.

Step 1: Identify host country(ies), sectors, output(s) and measures

In any particular country, the sector, output, and measure for rural electrification using solar home systems can be defined as follows:

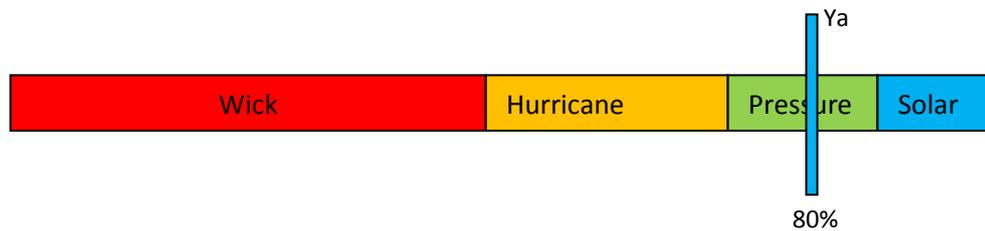


Step 2: Establish additionality criteria for the identified measures

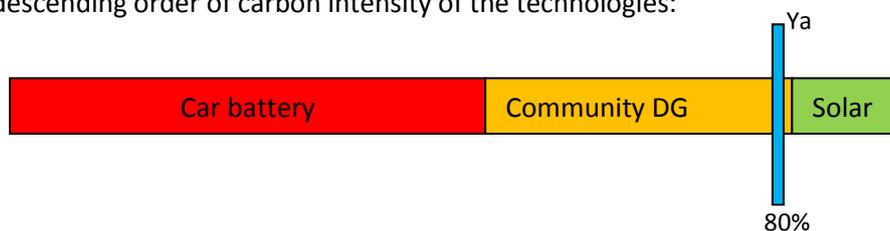
The choice of baseline technology and fuel for providing lighting and electricity for other appliances is based on a generic list of technology and fuel options identified (through a survey or information available with a relevant government agency) in a sector (household) identified. The information collected needs to be assessed to determine how the technologies and fuels in un-electrified areas can provide the minimum service level for each output and their likely availability, based on capital and running costs for the households, and must face no barriers. Based on the identified technologies and fuel, the following appliances have been identified for lighting:

- Kerosene wick lamps
- Kerosene hurricane lamps
- Kerosene pressure lamps and
- Solar home systems (SHS)

In accordance with the guidelines, the cumulative percentage of output (O_i) produced for *lighting application*—that is, providing light services using the identified technologies—is arranged in descending order of carbon intensity of the technologies:



Similarly, the cumulative percentage of output (O_i) produced for *household appliance application*—that is, providing electricity to other household appliances based on identified technologies—is arranged in descending order of carbon intensity of the technologies:



The next step is to prove that renewable technologies are commercially less attractive than any of the other technologies and meets both national and subnational regulations, if any. According to the guidelines, those technologies that (i) have lower GHG intensity than any of the technologies used to produce, in aggregate, more than Y_a percent of the output(s) O_i of the sector; and (ii) are commercially less attractive are included in positive lists and hence deemed automatically additional. According to the guidelines, a Y_a threshold of 80 percent is chosen in this example.

The most commonly used solar home system has a capacity of a 40–50 Wp and costs around \$500,²³ which in many cases is 3 to 5 times higher than the annual rural household's expenditure. A 1kW household diesel generator, which is the common size available, would cost around \$700,²⁴ while a car battery would cost under \$100. Considering the high purchase costs and low incomes of households, deployment of these systems faces significant financial, technical, and institutional barriers. In view of this, solar home systems for non-grid connected households would fall under positive lists and hence can be considered additional²⁵ in a country.

Step 3: Identify the baseline for the measures (for example, baseline fuel, technology, level of GHG destruction)

The guidelines request the identification of the technologies with the highest emission factor and contributing to Y_b percent of the output O_i in the sector. The technology with the lowest carbon emission factor is considered the baseline technology. According to the guidelines, the threshold Y_b has been fixed at 80%.

As these services are known to involve suppressed demand, it is very important to take this into account when identifying the baseline (and its emission factor) for these measures. However, the guidelines do not provide any specific guidance on how to do so when establishing the baseline technology using standardized baselines. In order to duly consider suppressed demand, attempts have been made to identify the baseline technology for supplying the required service levels by using the "*Guidelines on the consideration of suppressed demand in CDM methodologies*."²⁶

Given that the project activity will reduce the unit cost of providing lighting services dramatically, one approach to estimating the service level would be to use the *project* energy service level as the proxy for "satisfied demand". In other words, it is assumed that, after the implementation of the project activity, the households will face lower energy service prices and so will purchase adequate levels of those services. However, there are two challenges to this approach:

- Measuring energy consumption for one particular end use in rural households is challenging and measuring the actual *service* levels (for example, lumens of light) is not operationally feasible.
- Even with lower-cost services, the high poverty levels of the target population means that project service levels may not reach "satisfied demand" levels for many years. The gradual

²³ The example is based on a project implemented in Bangladesh: the RERED project. Source: Quantifying Carbon and Distributional Benefits of Solar Home System Programs in Bangladesh, The World Bank, January 2011.

²⁴ ESMAP (Energy Sector Management Assistance Programme). 2007. Technical and Economic Assessment of Off-grid, Mini-grid and Grid Electrification Technologies. ESMAP Technical Paper 121/07. Washington, D. C.: World Bank.

²⁵ Unless solar home systems are heavily subsidized and their cost is brought down below that of other alternatives.

²⁶ http://cdm.unfccc.int/Reference/Guidclarif/meth/meth_guid41.pdf.

increase of electricity consumption over time after electrification, sometimes by a factor 2 to 3 in a few years, supports the view that the initial consumption levels may not be adequate (Madubansi and Shackleton 2006; IED 2006; IEG 2008; IEA 2010)

Considering these factors, a more straightforward approach would be to establish a proxy for the “satisfied demand” level by defining a “minimum service level” of lighting, which would represent an adequate service to meet basic human needs. A similar approach could be applied to other services such as cooking and space heating.

According to an IEA/UNDP/UNIDO study,²⁷ the minimum service is described as the lighting output of two 15W CFLs for 5 hours per day.²⁸ Lighting service is measured in lumens or lux (lumens per square meter) over time (for example, lumen-hours). The lighting level of two 15W CFLs is approximately 1700–1800 lumens from the lamp, or 240 lux at typical working distance (Mills 2003).

Note that an alternative approach to defining the minimum service standard for lighting would be to look at recommended illuminance levels. There are numerous international standards for illumination requirements (IEA 2006), but none of these explicitly considers residential buildings, and certainly not in developing countries. Instead, residential spaces need to be compared with other spaces in commercial buildings with similar lighting requirements. Room categories such as “dining” or “hall” could approximate some residential spaces, while “bathrooms” in commercial buildings could be a proxy for residential bathrooms. Looking across published standards for more than a dozen countries, the lowest lighting service levels are 50–80 lux (lumens/m²) for spaces such as halls, assembly areas, bathrooms, and utility areas. The lowest general office or classroom values are 150–200 lux, with desk work and task lighting being 400+ lux. In other words, the use of a 15W CFL mentioned in the minimum service level above would in one room provide sufficient light for general indoor lighting, but less than what is considered ideal for desk and task work. Outdoor lighting is also very common in rural areas in African countries, and would need illumination levels that were similar if not higher. This means that the minimum service level defined here is conservative in comparison with international illumination standards.

Consequently, given the need to provide the minimum service level for lighting and the technology with the lowest emission factors and contributing 80 percent (Y_b) of the lighting needs (output O_i) in the sector, the baseline technology is identified as kerosene pressure lamps.

The use of kerosene lamps for lighting in un-electrified households is widespread throughout the developing world, and kerosene wick and hurricane lamps are by far the most common technologies (Mulder and Tembe 2006; IEA 2010; IEG 2008; Mills 2005; IEA 2006; IED 2006; Meier et al. 2010; Dalberg Global Development Advisors 2010). The amount of energy required to deliver higher service levels with traditional kerosene technologies, however, is so large that it is not realistic. For example, a 15W CFL installed by the project activity can deliver more than 25 times the lighting

²⁷ The most prominent source for a minimum service level related to household electricity is the work of the IEA, UNPD, and UNIDO on the amount of energy required to eliminate energy poverty worldwide by 2030 (IEA 2010).

²⁸ This is a similar number of hours to that proposed in the GTZ study cited in Practical Action (2010). It is also the same number of hours that kerosene wick lamps are used in India, according to the registered project under AMS-I.A. (REDS 2007).

service of a kerosene hurricane lamp, and these 25 hurricane lamps would consume 350 times more energy than one CFL. Obviously a household would not use this many hurricane lamps, but would instead switch to the next more expensive technology that would deliver more lighting service and was available in that area. For a household that does not have access to electricity, this would mean switching to a kerosene pressure lamp, because the investment is far smaller than a car battery or small generator, and the technology is also widely available. This switch is determined by the capital cost.²⁹ A typical pressure lamp can provide as much light as 15W CFL (O’Sullivan and Barnes 2007; Mills 2003).³⁰ For that reason, the baseline technology for the minimum service level for lighting is the use of two kerosene pressure lamps per household. However, under this path, the baseline technology could be different and is country-specific, as it also depends on the income levels of targeted households and the cost of various technologies available.

Country-specific minimum service levels for a targeted population can be assessed based on data collected from areas of comparable socio-economic characteristics that are already availed of similar services (see table A1 for electricity consumption values for various countries). The agreement on the minimum service level needed for a targeted population is generally political in nature and involves trade-offs between agreeing to provide certain minimum service levels to the population and maintaining environmental integrity by achieving adequate emission reductions and hence carbon revenues. Thus, the minimum service level identified using Path # 2 could be higher than the value under Path # 1, where a global minimum service value of 250 KWh was used, as a potential higher value was witnessed in countries like mentioned in Table A1.

A similar approach, be it without establishing minimum service levels as there is no pertinent information available, has been followed to identify the baseline technology for applications other than lighting for households. For appliances such as TV, radio, fans, and cell phone chargers, the baseline technology, as identified above, is car batteries; as the car battery involves a much lower up-front cost, this would be the lowest capital cost option (IEG 2008; IED 2006; Meier et al. 2010; ESMAP 2002) and also one that faces no barriers. While there are examples of car batteries being taken to a nearby village with grid or mini-grid electricity to be charged, this is the exception rather than the rule, because it raises the price of the power (due to transport costs) and is more difficult in the remote poor communities covered by this methodology. Therefore, the baseline technology identified is the car battery for other household applications.

Step 4: Determine the baseline emission factor where relevant

A baseline emission factor could be determined for the SHS considering the emissions from baseline technology for the minimum service level established.

²⁹ Another way to express this, in terms of section III.A of the “Guidelines on the consideration of suppressed demand in CDM methodologies” (EB62, Annex 6), is that capital cost is the major barrier considered by households, and is the reason to eliminate more efficient options such as a household-scale diesel generator.

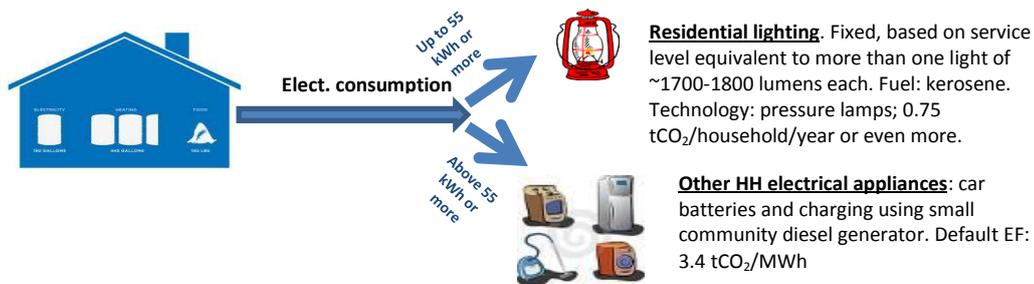
³⁰ The useful lighting rating for a pressure lamp at typical working distance is 182 lux, as opposed to a 15W CFL at 122 lux (Mills 2003). Although the pressure lamp can provide 50 percent more light, having only one pressure lamp could not provide the service of two CFLs. In addition, the CFLs might be needed in different rooms of the house, so one brighter light source could not provide the same service as two light sources.

Kerosene pressure lamps consume 0.08 liters of kerosene per hour (Mills 2003).³¹ At standard density, net calorific value and IPCC emissions factors, and 5 hours lighting per day, this amounts to 292 liters/year or 0.75 tCO₂/year per household for two pressure lamps.³² In other words, providing the minimum service level for lighting (that is, 55 kWh) in households that do not have access to electricity would emit 0.75 tCO₂ per year from kerosene combustion. This value could be even higher if a country-specific minimum service level value were established and used under this Path.

For other applications, it is proposed that small-scale diesel generators used for battery charging use an emission factor of 2.4 tCO₂/MWh because of their small size and low load factors (based on the table in AMS-I.F.). The typical efficiency of a battery charging system is 75 percent (Mills 2010), so the resulting emission factor is 3.4 tCO₂ per MWh.

Summary

The standardization achieved through guidelines for household level application of solar home systems is graphically summarized below.



³¹ This is a conservative estimate because the source cited by O’Sullivan and Barnes (O’Sullivan and Barnes 2007) shows 0.14 litres/hour.

³² Emissions per lamp would be 0.375 tCO₂/yr or 0.206 kgCO₂/hr.