Mr. Clifford Mahlung
Chairman of the CDM Executive Board
UNFCCC Secretariat
Martin-Luther-King-Strasse 8
D 53153 Bonn
Germany

Date: 25 June 2010

Subject: Call for public inputs on the specific aspects of a methodology framework for estimating GHG reductions from replacing fuel-based lighting with LED Systems

Dear Mr. Mahlung,

Orbeo welcomes the EB's decision at EB 54 to give interested stakeholders the opportunity to provide input to the specific aspects of a methodology framework for estimating GHG reductions from replacing fuel-based lighting with LED Systems.

Orbeo has developed one of the very first CDM project activities of this kind, "D.light Rural Lighting Project" in India, ref. no.: 2699, and I therefore believe to be able to provide some valuable input to the questions raised by the Small Scale Working Group (SSC WG).
In this submission I will use the D.light project as an example to illustrate a feasible emission reduction calculation approach under AMS I.A (v13).

I hope that the comments provided below are valuable input to the SSC WG's and EB's consideration of a methodological approach for LED lighting. Orbeo is available to provide further comments or clarifications during your deliberations. Please feel free to contact us at any time.

Kind regards,

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a) *Are kerosene or other fossil fuel lamp replacement projects viable CDM projects or POAs?*

Yes, we believe that fossil fuel lamp replacement projects are indeed viable CDM project activities or POAs. Inadequate lighting is a pressing issue in most developing countries (especially in Asia and Africa). About 1.5 billion people (22% of the world population) do not have access to electricity and are using predominately kerosene for lighting (EIA 2009). Baseline conditions are very similar in most developing countries. Kerosene lanterns are poor quality light sources and are a major source of both indoor air pollution and carbon dioxide emissions. There is a great need for clean, low cost solutions, but rural markets in developing countries are usually not attractive enough for private investors. Carbon financing can play an important role in the technology transfer from fuel based lighting to clean and efficient electric lighting in those countries.

b) *Is it better to use existing methodologies for fossil fuel lamp replacement projects and POAs or would be it better to develop a technology specific methodology?*

For small scale projects or PoAs, AMS I.A would be suitable, if a grid-charging option could be integrated. (Please also see the description of our approach below) AMS I.A (v14) allows for two different cases: either the substitution of a real existing technology (in this case the substituted technology should be scraped to avoid leakage) or the introduction of a new technology. In the second case it must be demonstrated what would have been the most likely available alternative technology to generate the equivalent quantity of energy. We found the second, energy based case very useful for the development of our D.light carbon project in India. For better understanding, see description of our approach below.

c) *i) Would a methodology that allows for a conservative value for default emissions savings be viable?*

We fully support the idea of introducing standardized default emission values to represent the wide range of different technologies and usage patterns. This will make carbon projects much easier, give useful guidance and reduce uncertainties for the project developer. (Annex I, par. 5.-9.)

ii) What if it only allowed a CER crediting period of 2 or 3 years?

An assumed product lifetime of 2-3 years would be acceptable as a conservative default value, but it should be possible to increase the crediting period for better quality products by lifetime certificates or through monitoring. (Annex I, par. 10.)

iii) Should the methodology allow for a monitoring option for development of emission reduction values and persistence of savings?

If a simple approach without monitoring is allowed (as suggested in the report Annex 2 on page 33), it should at the same time be possible to improve the conservative default values through voluntary monitoring.

d) *In Annex 1 to this document are a summary of issues (form the report referenced in footnote[1]) that arise from estimating baseline and project emissions for projects involving the replacement of kerosene lamps with LED lamps. Please provide comments on each of the issues identified in Annex 1 with respect to how (i) they should be addressed in a methodology and (ii) how they could be used for determining a conservative savings default value. These issues are:*

(i) *Pre-existing fuel-based technology:*

- *Fuel lamp types;* We agree with the report that wick-based kerosene lanterns are the most common baseline technology and can therefore be assumed as conservative default technology. (Annex 1, par. 9)

- *Fuel use rate (liters/hour);* We want to point out that an assumed fuel use rate of 0.025 liters/hour, as suggested in the report, would yield only 0.081 tCO_2eq per year and per lamp, which is really not much in a 1:1 lamp substitution approach (in particular if only a 2 year crediting period is allowed). However, as a conservative value, it might be acceptable. But the report's assumption that LED lamps can be completely financed through carbon income is in this case overly optimistic from our point of view, taking into account all the costs for setting up the whole project, establishing distribution structures in rural areas of developing countries plus the additional costs for carbon validation,

[1] The full text of the report titled **"From Carbon to Light: *A Framework for Estimating Greenhouse-Gas Reductions from Replacing Fuel-based Lighting LED Systems*"** is available as annex 2 to SSC WG 25 Annex 13.

registration and monitoring. Also the uncertainty of the actual carbon credit delivery in the end and the very volatile carbon prices make this business quite risky and not attractive for conventional investors. (Annex1, par. 9)

- *Utilization (hours/day and days/year);* The assumed 3.5 hours usage per day and 365 days usage per year suggested in the report is realistic for households from our point of view. For specific non-household uses (e.g. businesses, schools etc.) proving other usage hours should be allowed. (Annex 1, par. 9)
  The baseline case of electrified consumers relying on fuel-based lighting during power outages: It should not be overlooked that there is a lot of kerosene used in so called "electrified" areas, where grid performance is very unreliable and often interrupted. This case is already allowed for in AMS I.A (v14) under 1. b). The suggestion in the report to assume reduced usage patterns of less than 365 days for such cases makes sense, but might actually be difficult in practice as it requires detailed monitoring of the households' grid availability in case no official data exists (which is very possible as power utilities and governments usually do not like publishing such failures.) Also, it might be difficult to differentiate between users who are completely off-grid and such that have access to an (unreliable) grid. (Annex 2, page 19, 24)

- *Fuel emissions factor (kg CO2 /liter);* For the fuel emission factor, the given IPCC values for kerosene should be used (which has obviously been done in the calculations of the report as well). (Annex 1, par. 9)

- *Suppressed demand factor;* Suppressed demand is definitely an issue in all of the households which depend on fossil fuel based lighting. Due to the high inefficiency of the technology, costs for lighting are actually much higher than for electric lighting. This obviously leads to a situation where households receive less lighting service than they would need. As it is difficult to quantify suppressed demand, we would recommend not including any multiplier for this, as is suggested in the report, but in instead to waive the negative multiplier for leakage occurring from persistent use of fuel-based light sources. (Annex 1, par. 9)

- *Changes in lamp usage due to factors such as oil price increases/decreases/subsidies, numbers of people per household, income, and electrification;* **A dynamic baseline multiplier** as suggested in the report is very difficult to quantify in our opinion. As there can be several positive as well as negative factors which might differ from household to household (e.g. income levels), we suggest to leave this completely out of the calculations. In a conservative technology based 1:1 substitution approach, the influences of such factors are probably negligible. (Annex 1, par. 9)

(ii) <u>*Project Technology*</u>

- *Which new technologies and characteristics should be included (LED lamps with or without grid charging);* We regard it as a huge drawback that grid charging lamps cannot currently be included under AMS I.A. (v14) Many LED lights today have the option to be loaded in both ways, via PV and via another electricity source like the grid or a diesel generator. The flexibility is a big advantage for end-users and should not be restricted by a pure renewable energy methodology. See more input below under: Power conversion losses for grid charging. (Annex 1, par. 10)

- *Leakage (destruction or not of replaced lamps);* We agree with the report that it is not a feasible option to scrap old kerosene lanterns to prove that there is no leakage occurring. (On the one hand because they are low cost technologies which are easily replaceable and on the other hand because people cannot be forced to quit fuel based lighting sources altogether, as there might still be a demand for additional light–see also suppressed demand) In case of the **assumption in line with AMS I.A (v14), that the LED light is new and not necessarily replacing an existing technology**, but rather an energy service, leakage no longer poses a problem. (See also description of our approach below.) We also agree with the idea that cases where the lighting source is relocated to another household should not be penalized by carbon credit cuts, because actually a **positive spillover** can be expected if a household which gets electrified is giving away its LED lamp to friends or relatives with lower income where it would still replace kerosene. (Annex 1, par. 10)

- *Number of lamps replaced per new technology (e.g., LED) lamps;*

We agree with the conservative 1:1 lamp substitution approach suggested in the report. However, for very bright lamps or Solar Home Systems, there should be an option to prove that more than one standard kerosene lamp is substituted. (Annex 1, par. 10)

- *Service life;* As mentioned above, the suggested product lifetime of 2-3 years would be acceptable as a conservative default value, but it should be possible to increase the crediting period for better quality products by lifetime certificates or through monitoring. (Annex 1, par. 10)

- *Net to gross ratios for free ridership;* As we understand it, the meaning of this **Net-to-Gross factor** is to avoid that an LED product in a carbon project is substituting another already existing LED product rather than a kerosene lantern. However, this hardly seems to be a probable case. If people are already possessing a LED product, they would rather substitute another kerosene lantern than this LED product (except it is not well functioning, but in this case, they are anyway continuously relying on kerosene, so the baseline is the same). We therefore recommend not including this factor in the calculations. (Annex 1, par. 10)

- *Power conversion losses for grid charging;* The most practical approach for grid chargeable LED lights would be to include a simple discount factor for emissions caused by grid charging, like the 25% suggested in the report and a negligibly low factor in case of high-efficiency charging. The difficulty however is to prove how many people are actually using the PV charge option and how many are using the grid charge option. To be conservative, the discount factor would maybe have to be applied to all users. (Annex 1, par. 10)

- *Quality standards;* **Independent quality certificate**: It is surely a good intention to require a certificate of the products, as suggested in the report, but one has to keep in mind that this can add considerably to the project costs and until now there are no specific off-grid lighting standards available to our knowledge. (Maybe the IFC and World Bank initiative which is mentioned in the report will be a useful, lower cost solution?). In any case, we think a quality certificate should rather be rewarded than required. (Annex 2, page 31)

- *Allowable operating modes (such as PV or grid charging);* Please see comments above on the first point under (ii) Project technology.

e) *Please provide comments on the calculation of conservative emission reduction default factors as indicated in the tables located near the end of Annex 1, these begin with the table titled Proposed Carbon-accounting methodology, with examples. Values are strictly hypothetical.*

We suggest neglecting the following factors in the calculations:
Suppressed demand multiplier and **Leakage factor** (as these two are anyway weighing each other out to a sum of zero) and **Net-to-Gross value** (for the reasons provided above).

f) *Please provide other comments that may be helpful to the SSC WG of CDM EB to further work in this area.*

Cell phone charging option: We do not recommend generally subtracting 25% of emission reductions if there is a cell phone charging option, as long as the product can prove that a daily 3.5 hour usage for light is still possible over the crediting period. (Annex1, par.10)
Other baseline fuels besides kerosene: We suggest giving the option to simply subtract the percentage of other fuels used for lighting in a region (e.g. torches, vegetable oil, wood etc.) from the overall emission reductions, because this percentage is usually low and calculating emission reductions of e.g. non-renewable biomass is highly complicated and requires a whole new baseline study about the non-renewability fraction of the biomass in each region. (Annex 2, page 9)

Emission calculation approach developed for "D.light Rural Lighting Project" in India (CDM Registration Nr.: 2699, online-link: http://cdm.unfccc.int/Projects/DB/TUEV-SUED1245158196.62/view)

Used Methodology: AMS I.A (v13)

Our emission calculation approach is also completely in line with the current methodology AMS I.A (v14) and follows its logic by arguing that an energy service is replaced in the form of lighting service (lumen). This way we can, just like the methodology requests, calculate with the fuel consumption of a hypothetical technology that would have been used otherwise to generate the equivalent quantity of light. We use a **default value for the luminous efficiency of a wick kerosene lantern**. When calculating emission reductions based on lumen, there is also an incentive to use LED lamps with higher light outputs. It is of course necessary, to cap the light output for which one can claim emission reductions at a certain level that can still reasonably be produced by a (wick) kerosene lantern. For this we suggested another **default value for maximum light output of a wick kerosene lantern**, (e.g. 100 lumen, based on the list of sources in Table 1 below).[2]

This technology based approach avoids discussions on a dynamic baseline as well as the question of what percentage of the kerosene usage is exactly substituted in each household. And it does in some way even allow for suppressed demand in such households which cannot afford enough kerosene while not explicitly mentioning the concept of suppressed demand.

Practical calculation example for a solar lamp with a medium light output of 55 lumen:

Methodology AMS-I.A (version 14) comprises renewable energy generation units that supply individual households or users with electricity. The renewable generating units **may be new or replace existing fossil-fuel fired generation**. The energy baseline is the 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. In case of renewable energy lighting applications **the equivalent level of lighting service** is to be considered instead of energy. The methodology gives three options to calculate the baseline. In the following example option 2 is chosen:

Baseline emissions are calculated by multiplying the energy baseline with a default emission factor. As suggested by the methodology, the energy baseline is calculated by the lighting service, assuming a daily usage of the lighting devices of 3.5 hours.

Annual Energy Baseline:

$$E_{BL,y} = \sum_i \frac{LG_{i,y}}{1-l}$$

Where:

Parameter	Unit	Description
$E_{BL,y}$	Lumen*h or kWh	Annual energy baseline
$\sum_i$		Sum over the group i renewable energy technologies of the group of i renewable energy technologies implemented as part of the project activity
$LG_{i,y}$	Lumen*h or kWh	The estimated annual output of the renewable energy technologies of the group of i renewable energy technologies installed
l		Average technical distribution losses that would have been observed in diesel powered mini-grids installed by public programmes or distribution companies in isolated areas, expressed as a fraction

Additional parameter for conversion of lighting service (lumen hours) into energy service (kWh):

Parameter	Unit	Description	Value	Source
LE_{ker}	Lumen/W	The specific luminous efficiency of kerosene when burnt in a kerosene lantern	0.13	Louineau et al 1994

[2] In our project case in India, the validator did not accept a default light output cap value per lamp and instead required us to develop a trend of the local kerosene consumption per household and use this to cap our emission reductions per household (as option 3 of the methodology asks for a "trend adjusted projection of historic fuel consumption"). We agreed to follow his suggestion in order to get the project quickly registered, but the calculation of the trend turned out to be very difficult due to data unavailability. A simple default value for maximum light output of a kerosene lantern would have helped us a lot.

Unit conversion:

$$E_{BL,y}[kWh] = \frac{E_{BL,y}[Lumen \times h]}{LE_{\ker}[Lumen / W]} \times 0.001$$

Annual Energy Baseline for a 55 lumen lamp:
55 lumen * 3.5hr * 365days = **70262.5 lumen hr**
70262.5 lumen hr / (0.13 lumen/Watt) = **540480.769 Wh**

Annual emission baseline:

$$BE_{CO2,y} = E_{BL,y} \times EF_{CO2}$$

Where:

Parameter	Unit	Description	Value	Source
$BE_{CO2,y}$	tCO_2	Emissions in the baseline year y		
$E_{BL,y}$	kWh	Annual energy baseline in year y		
EF_{CO2}	tCO_2/kWh	CO_2 emission factor	$0.25884*10^{-3}$	IPCC 2006

Annual Emissions Baseline for a 55 lumen lamp: (with $EF_{CO2} = 0.25884*10^{-3}$ tCO_2/kWh = 0.0719 tCO_2/GJ):
540480.769 Wh * 0.0719 tCO_2/GJ * 3.6 * 10^-10 = **0.139 t CO_2/year**

Table 1 : List of sources for lumen and efficiency references:

Source	Technology description	Lumen figures	Efficiency figures
Louineau et al 1995	Kerosene lantern (Hurricane)	10-100 lm	0.05 - 0.21 lm/W
Rajvanshi et al 2003	Flame based devices in general	< 100 lm	
	Hurricane lamp in one specific sample	68 lm	0.35 lm/W
Nieuwenhout et al 1998 (data also used by The World Bank 1998)	"Light outputs of less than 20 lm are not meant for general lighting (just as orientation lights)"	>20 lm	
	Sample lantern		0.1-1.4 lm/W
	Other source referenced by them		0.02-2.4 lm/W
Peon et al 2005	Kerosene wick lamp	10 lm	
Michaelowa 2008	Wick lamp	20 lm	
	Hurricane	100 lm	
Mills 2003 (formerly unpublished data)	Several sample lanterns (all wick based)	up to 82 lm	
IEA and OECD 2006	See Mills 2005 below!		
Mills 2005	Lowest quality	8 lm	0.08 lm/W
	Hurricane lamp	40 lm	0.11 lm/W
	"The hurricane lamp as reference light source is a proxy for a mix of lamp types, fuels and range of utilization in practice."		carbon/energy: 0.72 kgCO2/MJ carbon/service: 2.3 kgCO2/klm