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TYPE III – OTHER PROJECT ACTIVITIES

Project participants shall apply the general guidelines to SSC CDM methodologies, information on additionality (attachment A to appendix B) provided at <http://cdm.unfccc.int/methodologies/SSCmethodologies/approved.html> *mutatis mutandis*.

III.AR. Substituting fossil fuel based lighting with LED lighting systems

Technology/measure

1. This category comprises activities that replace portable fossil fuel based lamps (e.g. wick-based kerosene lanterns) with LED[1] based lighting systems[2] in residential and non-residential applications (e.g. ambient lights, task lights, portable lights).

2. This methodology is applicable only to project lamps whose batteries are charged using one of the following options:[3]

(a) Charged by renewable energy system (e.g. photovoltaic systems or mechanical systems such as wind battery chargers);

(b) Charged by a standalone distributed generation system (e.g. a diesel generator set) or a mini-grid;[4]

(c) Charged by a grid that is connected to regional/national grid.

3. At a minimum project lamps shall be certified by their manufacturer to have a rated average life of at least 5,000 hours. Rated average life is the life certified by the manufacturer or responsible vendor as being the time at which the lamp's initial light output will decline by no more than 30%. In addition, the manufacturer shall certify that the project lamps' battery charging efficiency, at the time of purchase, is at least 50%.

4. Project Lamps shall have a minimum of one year warranty.[5]

[1] Light Emitting Diode lamps.

[2] LED based lighting system: one or more individual LED lamps, connected to a single rechargeable battery system, such systems may be portable or permanently installed, e.g. hard-wired. LED lamps may consist of one or more diodes. For the purposes of this methodology a single LED lamp, also referred to as 'project lamp(s)' throughout this document, must have a configuration of diodes with a minimum illumination of 20 lux.

[3] Project lamps may be charged by any of the listed options, however each individual project lamp shall be charged by only one of the charging options (e.g. 10,000 project lamps are charged by solar systems and 10,000 are charged by a grid, but none of the lamps are charged by both a grid and a solar system).

[4] Not connected to a national/regional grid.

[5] At a minimum warranty shall cover free replacement or repair of any failed lamps, batteries and where applicable solar panels.

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III.AR. Substituting fuel based lighting with LED lighting systems (cont)

5. The project design document shall explain the proposed method of distribution of project lamps. It shall also explain how the proposed project activity will:

(a) Ensure that the replaced baseline lamps are only those directly consuming fossil fuel. This can be done through documentation of the common practice of fuel usage for lighting in the project region (e.g. based on representative sample surveys, official data or peer reviewed literature);

(b) Eliminate double counting of Emission Reductions, for example due to LED manufacturers, suppliers of solar and/or battery equipment, or others claiming credit for Emission Reductions for the project lamps. At a minimum project lamps shall be marked as CDM project lamps;

(c) Ensure compliance with prevailing regulations pertaining to use and disposal of batteries.

6. The project design document shall include design specification of project lamps such as:

(a) Lamp wattage (in Watts) and illuminance (in lux);

(b) Lamp rated lifetime (in hours);

(c) Where applicable type and the rated capacity of renewable energy equipment for charging the battery (in Watts);

(d) Type (e.g. NiMH, Lead-Acid, Li-ion), and rated capacity of the battery (in Ampere Hours);

(e) Type of charge controller (e.g. active or passive);

(f) Autonomous Time and Daily Burn Time;

(g) Where applicable (with solar energy charging systems) maximum, minimum and average monthly Solar Fraction values during the year;

(h) Where applicable grid charging time;

(i) Physical protection against weather impacts (e.g. rain, heat, insect ingress).

7. The project activity shall restrict the number of project lamps distributed through the project activity to no more than five per household (for residential applications) or per business location (e.g. for commercial applications such as shops).

8. Measures are limited to those that result in emissions reductions of less than or equal to 60 kt CO_2 equivalent annually.

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III.AR. Substituting fuel based lighting with LED lighting systems (cont)

Boundary

9. The project boundary is the physical, geographical site where each project lamp is utilized. In addition:

(a) If the project lamps are charged by a renewable energy system then the project boundary includes the physical, geographical site of the renewable energy system;

(b) If the project lamps are charged by a mini-grid or a distributed generation system then the project boundary includes the physical, geographical site of the mini-grid or distributed generation system;

(c) If the project lamps are charged by a regional/national grid then the project boundary includes the physical, geographical site of the regional/national grid.

LED Lamp Effective Useful Life[6]

10. **Option 1:** Project Lamps are assumed to operate for two years after project lamp distribution to end-users. Therefore, emission reductions can only be claimed for two years;

11. **Option 2:** Project Lamps are assumed to operate for seven years after project lamp distribution to end-users, and thus emission reductions can be claimed for up to seven years per project lamp, if and if all the following conditions for the project lamps are met:

(a) At a minimum, LED lamps must be certified by their manufacturer to have a useful life of 10,000 hours. Within this time span, the relative luminous flux shall not reduce by more than 30% as per equation 1. Such claims shall be confirmed by a third-party testing organization using an applicable standard and testing protocol. As an alternative to long-term measurement of light output over the full lifetime of the lamp, a shortened measurement period of 2,000 hours may be chosen. If a 2,000 hour test period is used, the relative luminous flux shall not decrease by more than 10% during the 2,000 hours of continuous operation. As per the principles indicated in paragraph 4 of AMS-II.J "Demand-side activities for efficient lighting technologies", if the average life value is not available *ex ante*, it shall be made available for verification;

$$\phi_{Vrel} = \phi_v(t) / \phi_v(t_0) \quad \textbf{(1)}$$

[6] The crediting period of the project activity is either fixed 10 years period or three times seven years renewable. Project lamps may be distributed during multiple years as long as the elapsed lifetime of lamps can be unambiguously tracked to ensure that emission reductions are not credited beyond two years (for Option 1) or seven years (for Option 2) for any given project lamp.

Where:

ϕ_{Vrel}	Relative luminous flux after time t (shall be =>90% after 2000 hrs and =>70% after 10000 hrs)
$\phi_v(t_0)$	Initial luminous flux
$\phi_v(t)$	Luminous flux after time *t*

(b) The project lamps use a replaceable, chargeable battery. In addition, there must be documented measures in place to ensure that lamp owners have access to replacement batteries of comparable quality;

(c) Following criteria are satisfied with regard to the design specifications of the project lamps:[7]

(i) An illumination level of 20 lx for task and portable lights and 4 lx@1m for ambient lights;[8]

(ii) For charging option per 2 (b) or 2 (c), the Daily Burn Time (DBT) shall be equal to autonomous time after eight hours of charging;

(iii) For charging option 2 (a) with solar PV panel as the charging source, the minimum Solar Fraction achieved on a monthly basis during the year shall be 100%;

(iv) The battery capacity will be such that Autonomous Time of the Project Lamps shall be a minimum of 150% of DBT;

(v) With regard to dust and water tightness a minimum protection of IP41 is achieved in accordance to IEC 60529 or an equivalent national standard.

(d) Conditions 11 (a), 11 c (i) to 11 c(v) are confirmed by a third-party testing organization based on sample test[9] of project lamps using applicable national standards where such are available or alternatively the standards or test protocols indicated in annex 1 of this methodology may be used. The laboratory conducting and certifying the tests shall comply with the requirements of a relevant national or international standard, e.g. ISO/IEC 17025. If the testing results are not available *ex ante*, they shall be made available for verification;

(e) Project lamps shall be, in addition to the standard lamp specifications, be marked for clear, unique identification with the project activity.

[7] Based on Bopp, et al. (2009), see annex I for full citation.

[8] Minimum Illuminance (EVmin) for task lights and portable lights shall be EVmin ≥ 20 lx at one A4 sheet of writing paper (0.06 m^2). For ambient lights EVmin ≥ 4 lx at α ≥ 90°, r = 1m.

[9] The size of the sample shall be in line with the chosen testing standard.

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III.AR. Substituting fuel based lighting with LED lighting systems (cont)

Baseline Emissions

12. This methodology provides for a default annual baseline emissions factor for the project lamps distributed to end-users. The following assumptions are made about the equivalent baseline lighting system:

(a) Fuel use rate (liters/hour): 0.025 liters/hour;

(b) Utilization rate (hours/day): 3.5 hours per day;

(c) Utilization (days/year): 365 days per year;

(d) Fuel emissions factor: 2.4 kgCO2/liter;

(e) Leakage factor: 1.0;

(f) Number of fuel-based lamps replaced per project lamp: 1.0;

(g) Net-to-Gross factor: 1.0.

13. Baseline emissions are calculated per equation (2).

$$BE_y = DV \times GF_y \times DB_y \quad \textbf{(2)}$$

Where:

BE_y Baseline Emissions per project lamp in year y (tCO_2e)

DV Default Emissions Factor (0.08 tCO_2e per project lamp calculated using values indicated in paragraph 12)

GF_y Grid Factor in year y,

- Equal to 1.0 when charging option defined in paragraph 2(a) is used;[10]
- Equal to 1.0 if the project activity is for off grid households/communities[10] (defined as no grid access or less than 12 hours grid availability per day on an annual average basis);
- Otherwise it is equal to (1- fraction of time grid is available to the target households and communities/users in the region of project activity)

DB_y Dynamic Baseline Factor (change in baseline fuel, fuel use rate, and/or utilization during crediting period) in year y. Calculated as either:
Option 1: default of 1.0 in the absence of relevant information,
Option 2: value of 1.0+FFg where FFg is the documented national growth rate of kerosene fuel use in lighting from the preceding years (use the most recent available data of three or five years average (fraction)

[10] Combined with the demonstration of fossil fuel for lighting per paragraph 5 (a) it is assumed all of the baseline emissions would be from fossil fuel burning for lighting.

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III.AR. Substituting fuel based lighting with LED lighting systems (cont)

14. Alternative values for parameters in paragraph 12 (e.g. Fuel use rate, utilization rate) can only be used if adequate research/monitoring and documentation is provided by the project proponent e.g. strategic surveys and research conducted by national or local organizations, initiatives by international organizations or non governmental organizations or the project proponent to collect reliable and comprehensive data.

Project Emissions

15. There are no project emissions ($PE_y = 0$) if the project lamp charging mechanism utilized is as defined in:

(a) Paragraph 2 (a); or

(b) Paragraph 2 (b) if the minigrid or distributed generation system is entirely powered by renewable energy generation unit(s).

16. There are project emissions if the project lamp charging mechanism utilized is as defined in:

(a) Paragraph 2 (c); or

(b) Paragraph 2 (b) if the minigrid or distributed generation system is not entirely powered by renewable energy generation unit(s).

17. Project emissions per LED lamp are calculated as:

$$PE_{y,i,j} = W_i \times EF_{CO2,ELEC,y,j} \times \left(1/Eff_{i,j}\right) \times \left(D \times H\right) \times \left(1 + TD_y\right) \times 10^{-6} \quad \textbf{(3)}$$

Where:

$PE_{y,i,j}$	Average project Emissions in year y (tCO_2e) per Project Lamp
i	Type of Project Lamp
j	Type of charging mechanism as per paragraph 2
W_i	Wattage of project lamps distributed to end users, of type i (Watts)
$Eff_{i,j}$	Battery charging efficiency of lamps distributed to end users, as documented by lamp manufacturer, of type i for charging type j
D	Days of operation of project lamps per year, take 365
H	Hours of operation of project lamps per day, take 3.5
$EF_{CO2,ELEC,y}$	Grid Emission Factor in year y calculated in accordance with the provisions in AMS-I.D "Grid connected renewable electricity generation" or AMS-I.F "Renewable electricity generation for captive use and mini-grid" depending on the charging mechanism j (tCO_2/MWh)

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

Emissions reduction

18. Annual emission reductions are calculated as:

$$ER_y = \sum_{i,j} N_{i,j} \times \left(BE_{y,i} - PE_{y,i,j}\right) \times \left(OF_{y,i,j}\right) \quad \textbf{(4)}$$

Where:

ER_y Emission reductions in year *y* (tCO_2e)

$N_{i,j}$ Number of project lamps distributed to end users of type i with charging method *j*

$OF_{y,i,j}$ Percentage of project lamps distributed to end users that are operating and in service in year *y*, for each lamp type *i* and charging method *j*. Assumed to equal to 100% for years 1, 2 and 3. Equal to value determined per paragraph 21, for years 4, 5, 6 and 7[11]

The emission reductions shall be considered from the date of completion of distribution of the project lamps to end users.

Monitoring

19. Monitoring includes: (i) Recording of project lamp distribution data; and (ii) Where Option 2, paragraph 11 is chosen *ex post* monitoring surveys to determine percentage of project lamps distributed to end users that are operating and in service in year *y*.

[11] The years refer to the operational years of project lamps (e.g.. for project lamps deployed in year 3 of the crediting period years 1, 2 and 3 relate to the years 3, 4 and 5 of the crediting period and so forth).

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III.AR. Substituting fuel based lighting with LED lighting systems (cont)

20. During project activity implementation, the following data are to be recorded:

(a) Number of project lamps distributed to end users under the project activity, identified by the type of project lamps (lamp wattage, battery type, charging method, the date of supply);[12]

(b) For project lamps that will claim emission reductions for up to seven years, per option 2 paragraph 11, data to unambiguously identify each recipient of a project lamp, for all the project lamps distributed.

21. For project lamps that will claim emission reductions for up to seven years *ex post* monitoring surveys to determine percentage of project lamps[13] distributed to end users that are operating and in service will be conducted during the third year of the crediting period. Only project lamps with an original unique marking can be counted as operating and in service. While project lamps replaced as part of a regular maintenance or warranty program can be counted as operating, project lamps cannot be replaced as part of the survey process and counted as operating.

22. The following survey principles shall be followed for activities related to determining number of project lamps in service and operating under the project:

(a) The sampling size is determined by minimum 90% confidence interval and the 10% maximum error margin; the size of the sample shall be no less than 100;

(b) Sampling must be statistically robust and relevant i.e. the survey has a random distribution and is representative of target population (size, location);

(c) The method to select respondents for interviews is random;

(d) The survey is conducted by site visits;

(e) Only persons over age 12 are interviewed;

(f) The project document must contain the design details of the survey.

[12] Or a conservative estimation thereof based on distribution records.

[13] If project lamps are distributed with different charging methods, per paragraph 2 (a), 2 (b) and/or 2 (c), then the percentage operating in year 3 should be determined per each category of charging method, see equation 3.

Project activity under a Programme of Activities

23. If monitoring is required as per paragraph 18 to determine percentage of project lamps distributed to end users that are operating and in service, such monitoring will take place in the third year of each CPA and the results utilized for operational years 4, 5, 6 and 7 of project lamps of that CPA.

Annex I

Definitions

Daily burn time (DBT). The number of hours per day that the lighting system must provide light. A default value of 3.5 hours is used in this methodology.

Autonomous time (maximum possible burn time or run time, also known as battery autonomy). Time measured from switching on the light in the brightest mode to the point in time where the light output reaches a reduced percentage of its initial brightness such that it can not provide adequate illumination or until low voltage battery cut-off whichever is earlier. The test must be performed with a fully charged battery.

Solar Fraction(Charge to Discharge Ratio). It is an indicator of adequacy of matching of the capacity of the PV panel to charge the batteries to meet the daily load energy requirements i.e. the charge over discharge ratio of the project lamp that indicates how much of the daily energy use (charge) by the project lamp is provided by the solar panel. Solar fraction varies per season/month. This may be computed using simulation software'. Or alternatively 'Simplified Solar Fraction' (SSF) defined as SSF= Daily charge [Ah]/ Daily discharge [Ah] is computed as per the method in 'Stand-Alone LED Lighting Systems Quality Screening report' (see below for full citation).

Ambient lights. Lights to either fully or partly illuminate a room.

Task lights. Lights to illuminate a defined working area.

Portable lamps. Portable lamps have self-contained energy sources, are easily transported by hand, and are not permanently connected via piping to a central energy source.

Norms, Specifications and Test Procedures. Existing test procedures and specifications for LED lamps or other off-grid lighting systems, batteries, charge controllers and solar modules includes:

(a) Bopp,et al. (2009) "Stand-Alone LED Lighting Systems Quality Screening" Fraunhofer Institute for Solar Energy, Report commissioned by Lighting Africa (retrieved from <http://www.lightingafrica.org/files/LED_Lighting_TestProcedures_Draft_FISE_Aug09.pdf)>;

(b) PVGAP PVRS 5/5A, batteries;

(c) IEC 61951, NiMH batteries;

(d) IEC 61960, Li-ion batteries;

(e) CIE 127, LEDs;

(f) PVGAP PVRS 11A, Solar lights;

(g) IEC 62124 PV stand-alone systems, design verification and others.

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III.AR. Substituting fuel based lighting with LED lighting systems (cont)

History of the document

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