Rationale for default factors used in the proposed methodology SSC-I.L "Electrification of rural communities using renewable energy"

I. Background

1. This document provides the rationale and justification for default values for baseline emission factors in paragraph 9 of the draft methodology SSC-I.L "Electrification of rural communities using renewable energy" (See annex 4 to the SSC WG 35 report). It draws heavily from the Justification Document for Proposed New Baseline Methodology for Electrification of Rural Communities submitted along with the new methodology SSC-NM073 "Rural electrification of communities by grid extension", however it is not a complete endorsement of the values proposed in SSC-NM073.

II. Analysis and recommendation

2. **Minimum service level for electricity supply in rural households:** Minimum service level for electricity supply is set as per paragraphs 15(a) and 15(b) of the "Guidelines on the consideration of suppressed demand in CDM methodologies" i.e. 'based on national/international peer reviewed research or relevant studies and benchmarks that take into account that emissions will rise to achieve the international/national development goals'. **Minimum service level for electricity supply is set at 250 kWh per user per year taking into account research and studies listed in Table 1 and Table 2.**

Table 1: Literature compilation on minimum electricity consumption (global values)

Geographic coverage	Consumption (kWh/ user)	Source	Comment
Worldwide	500	AGECC (Advisory Group on Energy and Climate Change), 2010	The Secretary General's Advisory Group on Energy and Climate Change (AGECC) recommends 100 kWh/person/year for, "lighting, health, education, communication and community services", respective shares are not mentioned
Worldwide	250	IEA World Energy Outlook, 2009 (p. 132)	50 kWh/person/year in rural areas and 100 kWh/person/year in urban area, for an average household size of five people
Worldwide	250	IEA, UNDP and UNIDO, 2010	250 kWh/year 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
Worldwide	750	UNIDO, IAEA and KTH (Bazilian, Nussbaumer, Haites et al. 2010)	Medium estimate of rural electricity consumption

Table 2: Literature compilation on minimum electricity consumption (regional/local values)

Geographic coverage	Consumption (kWh/ user)	Source	Comment
Africa	300-600	Africa Infrastructure Country Diagnostic (Banerjee et al. 2008)	Subsistence household consumption
Indonesia	540	(IEG 2008, p.33)	Rural households
Lao PDR	504	(IEG 2008, p. 33-4)	Rural households
Phillippines	768	(IEG 2008, p.33-4)	Rural households
Bangladesh	312	(Barnes, Peskin, and Fitzgerald 2003)	Rural households
Bangladesh	420	(Khandker, Barnes, and Samad 2009)	Rural households electrified five years or less
Vietnam	432	(Khandker et al. 2009)	Rural households electrified less than two years
Peru	324	(Meier et al. 2010)	
Kenya	360	(Parshall et al. 2009)	Spare (i.e. 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

3. **Minimum service for lighting in rural households:** It is reported in the literature that lighting and TV account for more than 80% of electricity use in typical newly electrified settlements (IEG 2008). IEA report assumed two 15W CFLs consuming 20% of the total electricity in households that have basic energy services (IEA 2010) i.e. based on two 15W CFLs run for 5 hrs/day for 365 days consuming 55 kWh, 100W fan or TV run for 5 hrs/day for 365 days consuming 183 kWh and 10 W radio run for 5 hrs/day for 365 days consuming 18 kWh. **The methodology sets a minimum service for lighting at 55 kWh per user per year.**

4. **Baseline technology to meet the minimum service for** lighting: **One number of pressure kerosene lamp is chosen** based on the following aspects:

(a) Applying Steps 1 to 5 in paragraph 11 of the "Guidelines on the consideration of suppressed demand in CDM methodologies";

(b) The lighting service (useful lighting) provided by two 15W CFLs is 240 lux at typical working distance (Mills, 2003) whereas the lighting service from a kerosene pressure lamp at typical working distance is 182 lux (Mills, 2003). Although the two number of CFLs considered are seen to provide 30% more light than the one pressure kerosene lamp considered, there are uncertainties associated with this comparison such as:

(i) Service provided by portable pressure kerosene are not exactly comparable to fixed CFL lights;

(ii) Literature on light output from various types of pressure kerosene lamps is limited;

(c) Further following uncertainties were taken into account to make a conservative assumption:

(i) Uncertainties associated with choosing any one single baseline technology (under realistic conditions multiple technologies and multiple fuels may coexist and the transition will be through a ladder of choices);

(ii) There is an acute paucity of international standards/literature data for illumination requirements (IEA 2006) explicitly considering residential buildings in developing countries.

5. Therefore it is conservatively assumed one high pressure kerosene lamp for the baseline condition provides the lighting service amounting to 146 litres of kerosene consumption/user per year (see paragraph 6 below for the derivation of 146 litres). Such a value would, while integrating the issue of suppressed demand, be conservative and realistic in an overall global context as seen from the Table 3 below.

Table 3: Household kerosene consumption values reported in literature and PDD

Source	Coverage	Value (litres/year)
Mills (Mills 2005)	All developing countries	132 (36-360 range)
REDS CDM project	Rural India	131
D.Light CDM project	Rural India	83.8
Cambodia (UNDP 2008)	Rural households in Kampong Speu and Svay Rieng	15-23
Tanzania	Sumbawanga Region	36-60
Uganda (Harsdorff and Bamanyaki 2009)	Unelectrified rural households	38

6. **Emissions from baseline technology for the minimum service level**: Kerosene pressure lamps consume 0.08 litres of kerosene per hour (Mills 2003). At standard density, net calorific value and IPCC emissions factors, and 5 hours lighting per day, this is 146 litres/year or 0.375 tCO_2/year per user. Considering an amount of 55kWh/year of energy supplied to the user, it translates to 6.8 $kgCO_2$/kWh.

7. **Baseline emissions for other household appliances (**e.g. fans, radio, TV, refrigerator): The baseline technology is assumed to be small scale diesel generators (15 kW to 35 kW, 50% load factor, see AMS-I.F Table I.F.1).

8. **Baseline emissions for other uses** (e.g. small medium and micro enterprises (SMMEs), and street lighting, refrigeration, agricultural water pumps): The baseline technology is assumed to be small-scale diesel generators (35 kW to 135 kW, 100% load factor, see AMS-I.F Table I.F.1).

9. **Default availability factor for household renewable power systems**: The methodology currently only includes a default availability factor for solar photovoltaic systems, **a conservative**

values of 12% is chosen. The availability factor (or performance) for a solar photovoltaic system depends on many factors such as solar radiation (kWh/m^2/day), system orientation, system losses, battery energy efficiency, reliability, load requirements and user behaviour. Availability factors of 13%-26 % for solar PV systems are reported while as a rule of thumb three times the peak capacity of solar PV systems are often considered to estimate daily energy production from PV systems. Considering that methodology has simplified requirements for monitoring of energy production from the systems, particularly small sized **systems**, pending further analysis a conservative value of 12% is chosen.

Table 4: Reported availability factors for solar PV systems

Country/Region	Availability factor	Source
All developing countries	20%	(ESMAP 2007)
India	17-19%	(ESMAP 2010)
Rural areas in developing countries	15%	(ESMAP 2000)
Global (1800-2300 kWh/m^2-yr)	20.5-26.3%	(DOE & EPRI)
Sub-Saharan Africa - 4.5 kWh/m^2/day - 6.0 kWh/m^2/day	 13% 17%	(Deichmann et al. 2010)

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