Lighting the Bottom of the Pyramid

Project Brief Annexes

Annex A: Incremental Cost Analysis

Summary of Assumptions and Methodology

- To obtain per-household values for Ghana and Kenya, we consulted prior studies and conducted our own interviews and measurements during missions to each country. While the dominant source of energy use is kerosene, we also included the baseline use of candles, flashlights, LPG, and biomass. We also collected baseline data on non-fuel operating costs (equipment, replacement wicks, etc.). We combined these data with official national survey data (e.g. number of electrified households), to construct a "bottom-up" model that characterized the baseline structure and costs of providing lighting for non-electrified households and businesses. Fuel quantities were converted to expenditures using year-2005 energy and equipment costs, and to greenhouse-gas emissions using standard emissions factors. We compared our results with "top-down" national estimates of lighting kerosene demand and received good agreement. :

<u>Baseline Conditions</u>

- We separately modeled six categories of lighting equipment to be targeted under the proposed program, i.e. kerosene wick lanterns ("tins"), kerosene hurricane lanterns, pressurized kerosene lanterns, pressurized LPG lanterns, flashlights ("torches"), candles, and biomass.

- We collected country-specific demographic information on household size and electrification rates. This was coupled with end-user-level data lighting equipment ownership and utilization information from prior literature (including ESMAP studies) and in-country surveys and interviews of local experts conducted on our Missions to the countries. This was combined with information on first costs (lanterns), operating costs (maintenance, wicks, etc), and energy prices.

- Using the above information, we developed mathematical models of baseline energy demand, expenditures, and emissions, following standard accepted practices for summing across the various types of light sources (e.g. kerosene lanterns), their baseline market penetrations (e.g. % of households owning), utilization (e.g. hours/day), energy intensities (e.g. liters/hour), and emissions factors (e.g. grams of CO_2/liter of kerosene). These operating results were combined with equipment purchase and maintenance costs to obtain total costs of ownership.

<u>Program Scenario</u>

- In the baseline scenario (without the proposed program), near-term commercialization and successful uptake of WLED lighting technologies within our target market is assumed to be negligible. This is indicated by the low market penetration of solar lighting today in our subject countries (and almost no penetration at our "bottom-of-the-pyramid" target group).

- Rather than attempting to model the per-user penetration rate (e.g. lanterns per household or per small enterprise) and corresponding energy savings across a wide range of customer types, we stipulate penetration rates in terms of fractions of total fuel-based lighting energy use. This accounts for some share of the systems being targeted to high end users (e.g. fishermen) who will also have 100% substitution of the new systems for baseline systems on the one hand and, other end user types who will partially substitute their existing fuel and partially opt for increased numbers of light sources and service levels (maintaining some level of kerosene lighting use). As the proposed technology is entirely grid-independent and powered with renewable sources, the purchased energy savings are 100% in the cases where there is full substitution for the existing lighting equipment.

- Assumed costs of the proposed WLED technologies (US$25/system) were based on interviews of leading industry innovators in this area, and laboratory measurements. The performance (light levels) estimates are based on a combination of laboratory tests and field measurements of prototype LED lanterns made during our Missions.

- Several conservatisms were adopted. Not included in our savings estimates is the rising baseline, i.e. the rising number un-electrified populations, reduction in household sizes, and rapidly increasing numbers of un-electrified small and medium enterprises (which, pursuant to current trends, will in fact lead to increased fuel-based lighting energy demand during the course of the project) – perhaps by a factor of two over the coming decade. We also did not include savings due to the dual-uses (e.g. cell phone charging) that will likely be incorporated by some of the products brought to the market under this program. Equally important, given current trends, the efficiencies of the core technology (WLEDS) will likely double during the course of this project, translating into a halving of the equipment costs thanks to downsized PV and battery requirements.

- Extensive non-energy and productive-use benefits were identified, and documented in Annex A, but not quantified in the ICA. In addition, energy service levels increase dramatically (at least 10-fold) for recipients of the new technology.

Detailed Methodology for Calculating Economic Benefits and GHG Emissions Reductions Attributable to the Project

Remarkably, there are no prior estimates of national lighting-related energy use and costs for off-grid consumers in any Sub-Saharan country. To obtain per-household values for Ghana and Kenya, we consulted prior studies and conducted our own interviews and measurements during missions to each country. We also collected data on non-fuel operating costs (equipment, replacement wicks, etc.). We combined these data with official national survey data (e.g. number of electrified households), to construct a "bottom-up" model that characterized the structure and costs of providing lighting for non-electrified households and businesses. Fuel quantities were converted to expenditures using year-2005 energy and equipment costs, and to greenhouse-gas emissions using standard emissions factors.

Baseline Conditions

We estimate that approximately $1.4 billion is spent today for off-grid lighting (excluding solar lighting) in Ghana and Kenya (Figures ICA-1 and -2), accompanied by greenhouse gas emissions of 3.9 megatonnes of CO_2/year (Figure ICA-3). Due to population growth and other demographic trends, these values will increase to approximately $2.0 billion and 5.5 megatonnes within the next decade, at current energy prices.

Figure ICA-1. Off-Grid Lightin
$1.4 billion/year (2005)

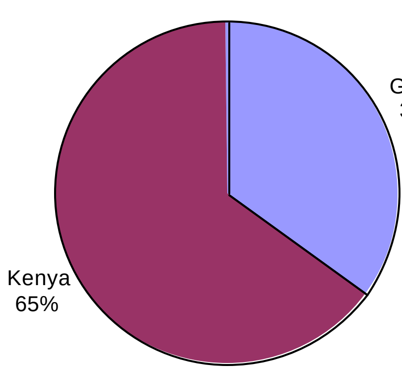
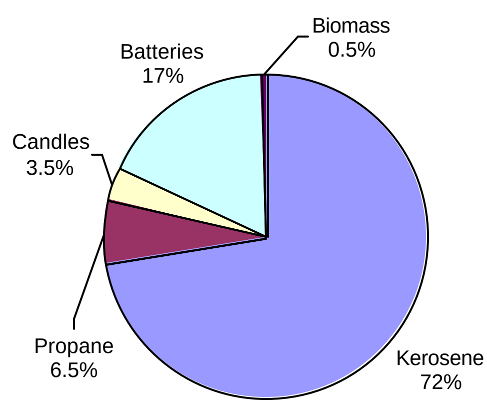
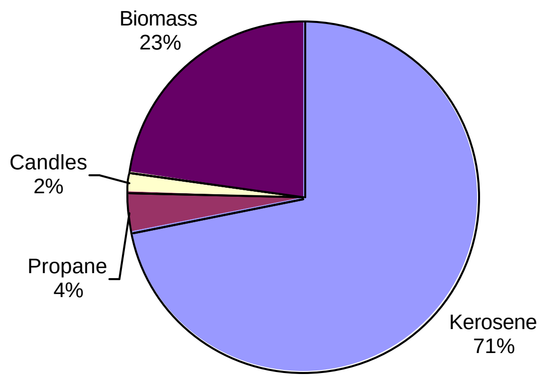


Figure ICA-2. Off-Grid Lighting by Source
$1.4 billion/year (2005)



Ghana and Kenya

Figure ICA-3. Off-Grid Lightin
3.9 MT CO2/year (2005)



Ghana and Kenya

For a variety of socioeconomic factors, the baseline demand for fuel-based lighting is increasing more rapidly than the overall economies in our target countries. This is driven by population growth superimposed over low electrification rates, rapid growth in small and medium enterprises (many of which are non-electrified and use fuel-based lighting), and a steady trend towards reduction in household sizes, which results in more fuel-based light sources per capita). Taken together, these factors will dramatically increase baseline off-grid lighting expenditures from the current level over the 10-year time horizon of our impact analysis. As a conservatism, these rising baseline levels are not included in our savings calculations.

Baseline conditions in our target market—non-electrified homes and businesses—are characterized by a diverse mix of off-grid lighting equipment including lanterns, candles, and flashlights, plus a variety of other hard costs such as replacement lanterns and batteries as well as equipment maintenance.

Top-level GEF cost-effectiveness calc ulations, based on our model, are presented in Table ICA-1 and key assumptions are outlined in Table ICA-2. A more detailed characterization of the baseline market, costs, and carbon dioxide emissions is outlined in Table ICA-3. This market model will be refined during project appraisal and implementation, as more detailed data on market structure and end-user behavior are gathered.

As an indicator of the likely conservatism of our baseline energy results (approx. $50 to 85/year-household), ESMAP research in the late 1980s estimated household outlays for off-grid lighting at up to $120/year. The Kenya Household Energy survey found a range of lighting expenditures from $36/household-year (in the year 2000) for kerosene-only households to $192/hh-year for households using a combination of kerosene and batteries. Adjusted to today's kerosene prices, the lower value would increase to $85/year and the upper value to at least $242/year (assuming no change in battery prices and similar uses of kerosene for all three tiers). Our model estimates an average $82/year for total lighting expenditures (kerosene, batteries, fuelwood) for the average rural household in Kenya for the year 2005. For Ghana, JICA (2005) estimates kerosene lighting costs of approximately $78/household-year (we estimate $86 for rural households and $49 for urban households), which also includes modest amounts of biomass and LPG.

In the baseline scenario (without the proposed program), near-term commercialization and successful uptake of WLED lighting technologies within our target market is assumed to be negligible. This is indicated by the low market penetration of solar lighting today in our subject countries (and almost no penetration at our "bottom-of-the-pyramid" target group), especially when tempered by the known failure rates of existing systems, and by the very small scale of efforts such as solar lantern development observed to date (hundreds to low thousands of units adopted by end users). While IFC has observed a range of organic entrepreneurial activity in the sector, including several products which use LED technology (intended, however, for relatively affluent consumers outside of our target market), the penetration rate under current conditions without a more deliberate effort by international companies to develop the market would not be expected to increase materially over the 10-year time horizon of our analysis. Thus, for the purposes of these calculations we assume a baseline that excludes the proposed WLED lighting technology among poor consumers. In the Project monitoring and evaluation plan, IFC will track development of a comparator market from the region outside of the scope of the Project activities. This comparator market should provide a proxy for a refined base case analysis; enabling the evaluator to adjust the baseline assumption accordingly.

Table ICA-1. GEF Cost-effectiveness Calculations

	Scenario I	Scenario II	Scenario III
Period of evaluation (years)	10	10	10
Fuel-based lighting energy savings	20%	10%	2%
GEF Cost	5,400,000	5,400,000	5,400,000
Consumer expenditure on new lighting technology, excl. replacement batteries (over 10 years, $)	96,475,041	48,237,521	9,647,504
Economic savings (over 10 years, $)	2,904,574,742	1,452,287,371	290,457,474
Reduced CO2 emissions (1000 tonnes, over 10 years)	7,817	3,909	782
GEF Cost/tonne CO2 ($)	0.69	1.38	6.91

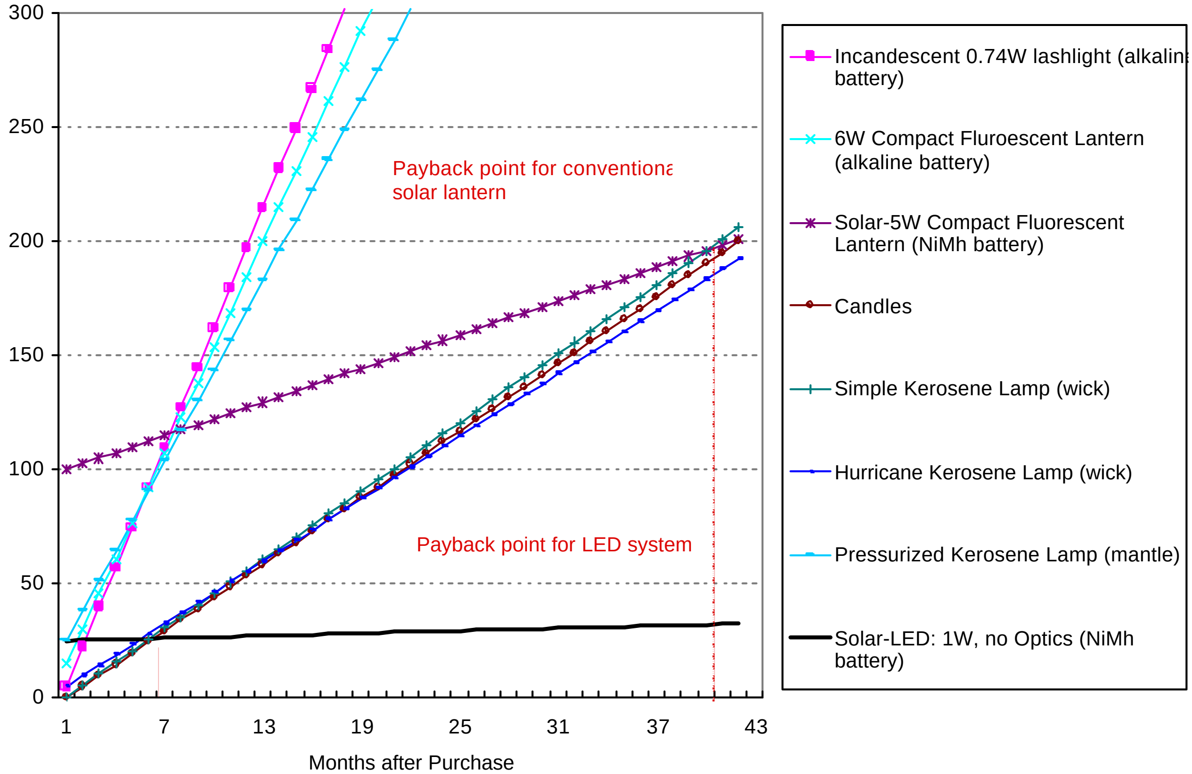
Values include 10 years of savings assuming existing lighting is replaced by non-fuel-powered LED systems at the indicated market penetration; no growth in baseline. Savings are undiscounted with zero nominal energy price increases over the period of analysis. Excludes substantial increases in energy service levels for end-users. Excludes impacts among electrified households.

Preliminary Estimates of Direct Economic Impacts

Direct economic impacts from the project arise from reduced energy use for lighting as well as reduced equipment, operation, and maintenance expenditures. While energy services will be increased dramatically (see below), we do not include economic estimates for the no-doubt-significant value of these higher services.

Commercial energy, candles, and batteries. Under the proposed project, lighting operating cost savings accrue from three sources: reduced liquid fuel combustion (predominantly kerosene in the countries in question), candles, and batteries for lighting purposes. We include each of these cost categories in our baseline and savings scenarios. The systems we expect the private sector to bring to market under this project will be highly cost effective on a per-household basis. As shown in Figure ICA-4, the payback times will be well under a year in many cases (indicated where the heavier "LED" line crosses the cumulative cost-of-ownership curves for prevailing lighting systems. The proposed systems will also be far more cost-effective than the current generation of solar lanterns or complete solar home systems, which have higher first costs as well as higher operating costs (due to shorter light source life and more costly battery replacements).

Figure ICA-4. Cost of Ownership Comparison: Off-grid Light Sources



Note: Analysis assumes 3 hours/day operation for each type of lighting

Biomass. As discussed in the main body of the proposal, biomass is used to a modest degree in our target markets for lighting purposes. About 3.8% of rural households in Kenya reported using fuelwood for lighting, and 8% of those using wood wastes for any purpose and 3.3% of those using farm residues reported using them for lighting purposes (Kamfor 2002). Field reports indicate that fires often continue to be burned for lighting and social interaction after preparation of the evening meal, often with fuel added to increase light output once cooking is complete. We have found no prior research on the amounts of biomass energy allocated to lighting, which is a remarkable knowledge gap we intend to address in the course of this project. For the purposes of our initial estimates, we assume that 1% of household fuel wood is used for lighting purposes. Our associated cost estimates are limited to the minority of households purchasing fuel (as opposed to collecting), and exclude the business sector. Our estimated costs and emissions impacts exclude agricultural wastes and charcoal. As seen in Figures ICA-2 and -3, the cost of biomass is low (much biomass is obtained without a cash transaction), but the corresponding greenhouse-gas emissions are significant. There is considerable uncertainty around these estimates.

Equipment and non-energy operating costs. The baseline lighting equipment employed by our target population is considerably less durable than the systems we are proposing, and incurs non-energy operating costs such as replacement batteries, wicks, mangles, and equipment repairs. These costs are included in our baseline and savings estimates.

Grid electricity. While not our primary target market, we expect that the new lighting systems brought to market under this project will also find application among existing electrified homes and businesses. This will be driven by improved lighting quality, reduced operating costs, and as a response to grid reliability problems. In the Nairobi's Kibera slum, for example, end users are charged by the socket for electric lighting, which can translate into an effective cost many times higher than the prevailing retail price of electricity (approximately $0.50/kWh). We have not included potential savings from the use of WLED technologies by grid-connected consumers.

We developed three scenarios for potential project impacts, with results shown in Table 1.

- Scenario I – 20% lighting energy savings

- Scenario II – 10% lighting energy savings

- Scenario III – 2% lighting energy savings – assuming that program expenditures implic itly translate on a 1:1 basis directly into lamp purchases ($10,000,000/$25 per lamp) but no additional market leverage is achieved.

System Types and Costs

While IFC will not dictate technology characteristics or pricing, under the project a variety of technology options will be brought to the market, with different performance characteristics (and applications) and price levels. At the "entry level" of the spectrum will be stand-alone light sources (usable individually or in multiples) at price points in the vicinity of US$5 each. In practice, lights of different sizes (light output) would be offered, ranging from 0.1 to 1.0 Watts, and perhaps higher for very specialized applications, with a range in prices for perhaps $2 to $10 each. These will be powered by removable "AA" style (or similar) batteries, already available in the local marketplace. In this configuration, either disposable batteries at ~$0.20 each (lower first cost and higher operation cost) will be used, or rechargeable batteries at ~$1.25 each charged by local micro-enterprises using solar photovoltaic or grid-based charging at a cost of perhaps $0.10 per charge. Alternatively, third parties may elect to establish micro-grids with central power at the scale of a cluster of homes or greater. Consumers can graduate from disposable to rechargeable batteries or micro-grids as they become able to afford third-party recharging or their own charging device. The next step upwards will be to stand-alone systems with integrated charging (PV, hand cranked, etc). These systems would be modular in that they could be purchased incrementally (e.g. charger ~$15-$20) plus one or more light points at perhaps $5 each. Lastly would be relatively high-end configurations including a package with multiple light sources, charging, and even ancillary services such as cell phone or radio power. These would be valued more highly, e.g. because they would defer phone charging costs of ~$10/month) and would be brought to the market at a correspondingly higher price point.

The realm of application in most cases will be "task" as opposed to "ambient" lighting. Existing WLED technologies allow for rather uniform illumination over an area of 1 to 5 square meters. Indirect applications, using simple reflection off of white paper or fabric, were seen on our mission to provide highly acceptable ambient illumination, at levels suitable for social interaction over a large area.

Based on current trends, the efficiencies of WLEDs will improve considerably—probably doubling—even over the short duration of this project, while the costs per unit of light output decline. Improved WLED performance will allow for downsized charging systems, further reducing total system costs. As a conservatism, this learning-curve effect has not been incorporated in our savings estimates.

Conservatisms and Caveats in the Analysis

The preceding analysis did not include expected increases in baseline energy use and costs that can be expected over the period of analysis. This is driven by population growth, corresponding growth in small and medium enterprises (many of which are non-electrified and use fuel-based lighting), and a steady trend towards reduction in household sizes (Liu et al, 2003), which creates a trend towards more fuel-based light sources per capita, over and above that caused by growth in population). Moreover, according to projections from the International Energy Agency (2002), the non-electrified population will increase by 40% in Sub-Saharan Africa between 2000 and 2025.

In addition, as these economies develop, consumers will move up the traditional "lighting ladder" through increasingly more fuel-intensive lantern types (wick to hurricane to pressure) and longer operating hours, per-household lighting energy use will increase further. As fuel wood becomes scarcer, we can also anticipate a higher share of people paying for (rather than freely collecting) fuel, a small but important (and probably increasing) fraction of which is used for lighting. If observed trends continue, more biomass may be used for lighting as the cost of fuels increases. Energy price increases will, of course, also elevate the baseline costs.

The analysis also did not include fuel- or battery-based lighting used among electrified households in response to high electricity prices and/or power outages (particularly frequent at present in East Africa). We did not estimate the energy use and costs associated with grid-based end users who may opt to switch to grid-independent LED sources, or those associated with increasingly popular grid-based car battery charging services (such batteries are often taken to the home and used to operate lights) or cell-phone charging which may be provided by some of the systems brought to the market under this project by private sector partners.

Taken together, these factors could as much as double the baseline energy use, and increase the expenditures by even more. In preparing this analysis, we drew on the best-available data for each country. Improved estimates will utilize new market research conducted during the course of the project.

Potential scenarios under which the project attains lower impact than described above are enumerated in section entitled "Risk Management." Actual outcomes will be particularly sensitive to assumed household size and numbers of small businesses using fuel-based lighting (which, in turn, influence the numbers of lanterns in the stock). Utilization rates and other operational assumptions are shown in Table ICA-4.

Energy savings under the program are articulated as fractions of total lighting energy, as opposed to numbers of households or light sources. It is important to note that the potential for lighting-related CO_2 reductions from traditional whole-house solar electric systems have been curbed (Hankins 2005) in part by the limited efficacy of traditional fluorescent lighting used therein, and end-users sometimes prefer to use scarce solar electricity for other end uses (e.g. television). Consequently, among relatively affluent households, the introduction of alternative lighting may be taken as an augmentation to existing lighting rather than as a substitute (as has been observed for current solar home systems) and thus could result in little if any reduction in energy user or associated emissions. We believe that for our target market this "take-back effect" will be limited, and virtually non-existent in the case of single-vendor night-market businesses or the poorest households or refugees (which use only one light source and can barely afford the kerosene they use today). More specifically, we believe that the proposed technology will be significantly more successful than conventional solar lighting because:

a. it will provide more effective lighting at lower cost than the alternatives
b. it will be targeted at lower income households which are more likely to take the solar light as a substitute to (rather than augmentation of) existing kerosene, and

c. it will make possible more than one affordable point of light for a given consumer.

It is important to note that, even where substitution is not achieved, the standard of living (in terms of lighting service levels) is increased considerably. These dynamics will be explored carefully in the course of the project's market tests and consumer research.

The ultimate penetration rates, and thus energy and emissions savings, will be also directly linked to the mature market prices of the WLED systems. For the poorest households, particularly low-cost systems will be needed. While this is also the segment most associated with the use of biomass for lighting, it is also the case that even the lower wattage WLEDs will give superior and significantly less costly or labor-intensive illumination to that provided by firelight.

Preliminary Estimates of Environmental Benefits

Greenhouse-gas reductions. GHG reductions under the project will arise from the substitutions of non-fossil lighting energy sources for fossil-based ones or for biomass-based lighting.

Our three program scenarios result in the following costs of avoided carbon dioxide emissions, respectively: $0.69/tonne, $/1.38/tonne, and $6.91/tonne.

Reduced solid waste production. Based on interviews with Eveready Kenya, and our bottom-up analysis of flashlight utilization (Table ICA-3), we estimate that 260 million dry-cell flashlight batteries are disposed of annually in Ghana and Kenya. The systems we propose will offset this in two ways. Firstly, they will utilize smaller rechargeable batteries (which will last for 1 to 2 years, rather than a few days or a week in the baseline. They will also to some degree substitute for existing lighting using remotely charged car batteries (not included in the aforementioned number), which entails the introduction of battery acid and lead into the environment.

Forest resources. As discussed above, there is a measure of fuelwood use for lighting. To the extent that this project displaces this fuel with improved lighting strategies, reduced impacts on forest resources, erosion, and other well-known benefits of fuel wood conservation will accrue.

Enhanced Productivity and Associated Economic Benefits

The baseline conditions surrounding lighting correlate with severe curtailment of a variety of social needs and unproductive operating conditions for small and medium enterprises. These range from lighting for education to product sales.

The proposed project offers a cluster of social benefits that are rarely encountered with traditional energy efficiency improvements. For example, baseline service levels are normally maintained or marginally improved through energy efficiency projects. In this case, energy service levels will increase by at least ten-fold (and in some cases 100-fold), as measured in terms of illumination levels (e.g. lux, lumens per square meter). This was verified by side-by-side field measurements taken of baseline conditions and LED alternatives during our Missions, as well as prior laboratory measurements of typical kerosene lanterns versus LED light sources (Mills 2005). LED task lighting can even improve on service levels in already electrified contexts.

The following benefits are material—and in fact perhaps the most valuable—impacts of the project, but have not been quantified for the purposes of this Incremental Cost Analysis.

Literacy. There are approximately 18 million school-age children in our target countries (7 million in Ghana and 11 million in Kenya). We have observed baseline lighting services in schools as low as 2% of that specified for reading tasks, and the costs of providing this lighting often limit the number of hours available for study. Formal evening study periods are common for older students in our target countries, and typically one or two kerosene lanterns are provided for 30 or 40 students. Our proposed lighting systems can provide substantially higher levels of illumination at lower cost. We have also identified chalkboard lighting as an appropriate application for the types of systems to be developed by the private sector under this project.

Retail Sales. As discussed in the main body of this proposal, poor lighting is a constraint to both the number of hours that businesses can remain open in the evening and in rate of sales. Upon examining LED prototypes during our Missions, street sellers universally agreed that their sales and profits would increase with the improved lighting. LED systems would also avoid some market closures necessitated today by windy or rainy conditions that make it impossible to use flame-based lighting.

Safety. We have identified several safety-related benefits of the proposed systems. Firstly, they offer nighttime security lighting where it is currently unaffordable or impractical. Secondly, they eliminate an important fire hazard posed by flame-based lighting sources. Refugee camp officials interviewed during our Mission to Kenya pointed to the potential for improved women's safety in refugee camps if affordable and portable lighting was made available.

Health. Poor indoor air quality (IAQ) is a well-known health problem in the developing world. While the primary source of IAQ problems stems from the use of biomass for cooking, kerosene combustion (as well as modest fuel wood combustion for lighting purposes) contributes as well. There are also reports of frequent burns among children due to contact with hot kerosene lanterns and chimneys.

Time. Rural end users can travel long distances to obtain kerosene, batteries, or other necessary lighting products. The Kenyan household survey indicates an average roundtrip of 40km for rural households to obtain fuel. More durable and self-powered solutions will reduce this expenditure of time.

Refinement of these Estimates Using Sub-Project Data

Through its work with prospective local partners, national statistical bodies, and NGOs, IFC is identifying and collecting additional information on the off-grid lighting market. In Project Appraisal, IFC will refine its estimate of Project GHG emissions reductions further.

Table ICA-2. Preliminary Economic and Carbon Dioxide Baseline Analysis: Key Assumptions.

		Ghana			Kenya		
		Rural Households	Urban Households	Non- household	Rural Households	Urban Households	Non- household
ECONOMIC DATA							
Currency		Cedis	Cedis	Cedis	KSh	KSh	KSh
Exchange Rate	local currency/US$	9200	9200	9200	70	70	70
Energy Prices							
Kerosene	price/liter	9,000	7,000	7,000	70	60	55
LPG	price/kg	*15,114*	*15,114*	*15,114*	115	115	115
Candles	price/kg	*22,303*	*22,303*	*22,303*	*170*	*170*	*170*
Biomass	price/kg	212	212		0	0	
Operating costs							
Wicks	cost/year	*12,000*	*12,000*	*12,000*	120	120	*120*
Batteries	cost/battery	1,500	1,500	1,500	40	40	40
Replacement chimneys	cost/chimney-year	3,000	3,000	3,000	100	100	100
Torch lamps	cost/replacement bulb	*2,760*	*2,760*		*21*	*21*	
Mantles	cost per mantle	*4,600*	*4,600*	*4,600*	35	35	35
Pressure lamp service (including mantles)	cost per 1000 hours	*82,128*	*82,128*	*82,128*	625	625	625
DEMOGRAPHIC DATA							
Population (2005)	millions	13,669,404	7,360,449		24,695,601	9,133,989	
Electrification rate	%	17%	77%	*17%*	4%	46%	*4%*
with electricity	millions	2,323,799	5,667,545		987,824	4,201,635	
without electricity	millions	11,345,606	1,692,903		23,707,777	4,932,354	
People/household	number	5.1	5.1		*5.0*	*4.3*	
Total number of customers (est. 2005)	number (HHs; businesses)	2,680,275	1,443,225	3,108,204	4,939,120	2,124,184	5,000,000
of which unelectrified	number (HHs; businesses)	2,224,629	331,942	2,579,809	4,741,555	1,147,059	4,800,000
of which electrified	number (HHs; businesses)	455,647	1,111,283	528,395	197,565	977,124	200,000
Selling shops	number per 1000			*148*			*148*

Table ICA-3a. Preliminary Economic and Carbon Dioxide Baseline Analysis.

		Ghana		
		Rural Households	Urban Households	Non- household
LIGHTING SOURCES AND COST				
Kerosene - tin lantern				
Customers using this fuel for lighting	%	82%	22%	90%
Utilization	hours/day	2	2	2
Consumption	liters/month	3.0	3.0	3.0
Equipment cost	cost per unit	3000	3000	3000
Cost of Ownership				
Equipment purchase	(millions/year), local currency	13,187	1,905	16,784
Fuel	(millions/year), local currency	712,096	80,012	704,941
Other	(millions/year), local currency	26,374	3,810	33,569
Kerosene - hurricane				
Customers using this fuel for lighting	%	82%	22%	82.0%
Utilization	hours/day	2	2	2
Consumption	liters/month	2.4	2.4	2.4
Equipment cost	cost per unit	16,000	16,000	16,000
Cost of Ownership				
Equipment purchase	(millions/year), local currency	17,583	2,540	20,390
Fuel	(millions/year), local currency	######## ######################	####### ###############	######## #################
Other	(millions/year), local currency	32,967	4,763	38,231
Kerosene - pressure lantern				
Customers using this fuel for lighting	%	3.8%	3.7%	10.0%
Utilization	hours/day	5	5	5
Consumption	liters/month	15	15	15
Equipment cost	cost per unit	222,114	222,114	222,114
Cost of Ownership				
Equipment purchase	(millions/year), local currency	5,656	2,965	17,259
Fuel	(millions/year), local currency	164,998	67,283	391,634
Other (mantles+service)	(millions/year), local currency	15,266	8,004	46,587
LPG - pressurized lantern				
Customers using this fuel for lighting	%	2.0%	2.0%	2.0%
Utilization	hours/day	5	5	5
Consumption	kg/month	11.25	11.25	11.25
Equipment cost	cost per unit	222,114	222,114	222,114
Cost of Ownership				
Equipment purchase	(millions/year), local currency	2,381	1,282	2,762
Fuel	(millions/year), local currency	109,378	58,896	126,841
Other (mantles+service)	(millions/year), local currency	8,035	4,326	9,317
Battery Torch				
Customers using this fuel for lighting	%	53%	46%	
Utilization	hours/day	3	3	
Consumption	batteries/'month	3	4	
Equipment cost	cost per unit	15,000	15,000	
Cost of Ownership				
Equipment purchase	(millions/year), local currency	21,308	9,958	
Batteries	(millions/year), local currency	76,709	47,800	
Other (replacement bulbs)	(millions/year), local currency	286,212	133,759	
Number of batteries	millions of units/year	51	32	
Candles				
Customers using this fuel for lighting	%	3.5%	29.0%	
Utilization	hours/day	4	4	
Consumption	kg/year-household	16	16	
	kg/year - national	1,521,801	6,789,573	
Cost of Ownership				
Candles	(millions/year), local currency	####### ######################	######## #############	
Biomass				
Customers using this fuel	%	87.4%	25.6%	
Customers purchasing most or all of fuelwood	%	17.2%	57.6%	
Customers using this fuel for lighting	%	0.9%	0.4%	
Fraction of all biomass for light	%	1.0%	1.0%	
Annual biomass use	kg/year-household (households using biomass)	2,110	2,110	
National biomass use for lighting	kg	49,424,985	7,795,245	
Cost of Ownership	(millions/year), local currency	13,743	7,255	

Table ICA-3b. Preliminary Economic and Carbon Dioxide Baseline Analysis.

		Kenya		
		Rural Households	Urban Households	Non- household
LIGHTING SOURCES AND COST				
Kerosene - tin lantern				
Customers using this fuel for lighti	%	43.9%	14.2%	*90%*
Utilization	hours/day	*2*	*2*	*2*
Consumption	liters/month	3.0	3.0	3.0
Equipment cost	cost per unit	20	20	25
Cost of Ownership				
Equipment purchase	(millions/year), local currency	87	12	225
Fuel	(millions/year), local currency	5,464	652	8,910
Other	(millions/year), local currency	260	36	540
Kerosene - hurricane				
Customers using this fuel for lighti	%	66.4%	72.4%	*90%*
Utilization	hours/day	*2*	*2*	*2*
Consumption	liters/month	2.4	2.4	2.4
Equipment cost	cost per unit	450	450	450
Cost of Ownership				
Equipment purchase	(millions/year), local currency	738	346	1,013
Fuel	(millions/year), local currency	##### ##############	##### #############	##### ###############
Other	(millions/year), local currency	722	338	990
Kerosene - pressure lantern				
Customers using this fuel for lighti	%	3.8%	3.7%	*10%*
Utilization	hours/day	*5*	*5*	*5*
Consumption	liters/month	15	15	15
Equipment cost	cost per unit	1,690	1,690	1,690
Cost of Ownership				
Equipment purchase	(millions/year), local currency	79	33	211
Fuel	(millions/year), local currency	2,365	849	4,950
Other (mantles+service)	(millions/year), local currency	214	90	570
LPG - pressurized lantern				
Customers using this fuel for lighti	%	*2.0%*	*2.0%*	*2.0%*
Utilization	hours/day	*5*	*5*	*5*
Consumption	kg/month	11.25	11.25	11.25
Equipment cost	cost per unit	*1,690*	*1,690*	*1,690*
Cost of Ownership				
Equipment purchase	(millions/year), local currency	33	14	34
Fuel	(millions/year), local currency	1,534	660	1,553
Other (mantles+service)	(millions/year), local currency	113	48	114
Battery Torch				
Customers using this fuel for lighti	%	52.5%	52.0%	
Utilization	hours/day	*3*	*3*	
Consumption	batteries/'month	4	4	
Equipment cost	cost per unit	150	150	
Cost of Ownership				
Equipment purchase	(millions/year), local currency	389	166	
Batteries	(millions/year), local currency	4,979	2,121	
Other (replacement bulbs)	(millions/year), local currency	3,975	1,693	
Number of batteries	millions of units/year	*124*	*53*	
Candles				
Customers using this fuel for lighti	%	3.5%	29.0%	
Utilization	hours/day	*4*	*4*	
Consumption	kg/year-household	16	16	
	kg/year - national	2,804,323	9,993,104	
Cost of Ownership				
Candles	(millions/year), local currency	### ################	##### #############	
Biomass				
Customers using this fuel	%	89.0%	7.1%	
Customers purchasing most or all fuelwood	%	17.2%	57.6%	
Customers using this fuel for lighting	%	3.8%	0.4%	
Fraction of all biomass for light	%	*1.0%*	*1.0%*	
Annual biomass use	kg/year-household (households using biomass)	3,394	3,394	
National biomass use for lighting	kg	149,194,026	5,118,730	
Cost of Ownership	(millions/year), local currency	316	36	

le ICA-4. Technical assumptions regarding lighting technologies.

umptions: Light Sources	Candles	Tin lamp	Hurricane Lantern	Pressurized Kerosene Lantern	Pressurized LPG Lantern	Torch (flashlight)	White LED
eful life (years)	2 inches/hour	0.5	2	4	5	1	5
ization (hours/day-device)	4	2	2	5	5	3	varies depending on which other technology is replaced
ntles (hours/mantle)	-	-	-	252	*252*	-	-
urs per flashlight bulb	-	-	-	-	-	15	-
el Use Rate	0.011	0.05	0.04	0.10	0.075	4	0
	(kg/hour)	(liters/hour)	(liters/hour)	(liters/hour)	(kg/hour)	(batteries/month)	-
issions factor	3.10	0.072	0.072	0.072	0.060	0	0
	kg CO2/kg candle wax	kg CO2/MJ	kg CO2/MJ	kg CO2/MJ	kg CO2/MJ	-	-

Fuel use rates from van der Plas (1988), direct measurements, and user-reported values.

Annex B: Logical Framework Matrix

Objectives	Performance Indicators	Data Sources	Assumptions
Goal: **To reduce CO_2 emissions by displacing fossil fuel lighting in rural in Ghana and Kenya.** The project will be establishing a platform within which manufact WLED lights and other modern lighting technologies shall meet t develop innovative products and distribution channels to meet the of the *non-electrified* populations in the above countries. The proj work with the private sector to identify barriers to the market's development, and address barriers by doing things that the industr do itself (eg, provide credible, unbiased consumer information, or high quality products). A related goal is to improve the quality of life of the *non-electrifie* population through the use of lower polluting and lower cost / hig quality lighting systems.	Impact • Tons of GHG avoided by displacing fuel-based lighting using WLED or other electric lighting options	• Program records • Interviews of wholesale suppliers,retailers, and manufacturers to estimate unit sales • Technical estimate of number of fossil fuel burning lamps displaced	• Increased use of WLEDs would reduce overall CO_2 emissions • End user adoption of WLEDs beyond immediate program participants • WLED products can be produced at an acceptable price point for the target market, or acceptable finance options enable access to the technology
Purpose: To accelerate the development of the African market for high quality lighting products by lowering barriers to product development, market entry, consumer acceptance, consumer access, affordability	Outcome/Impact	• Participating manufacturers • Program records • Local consultant or academic expert opinion • Stake-holder surveys or other data indicating changes attributable to our work • Consumer surveys capturing attitudes about modern lighting products and consumer habits • Market study, including retail product survey	• End users see the WLED units as superior to the fuel based alternatives and move to new product • Manufacturers willing to develop acceptable products for the market and invest in distribution • Product development and manufacture successfully produces reliable and affordable product • End users would be willing to make investments once barriers are reduced.

Objectives	Performance Indicators	Data Sources	Assumptions
Component Objective1: To lower supplier barriers to market entry. (Work with private sector firms to address constraints to entering the market. This includes identifying end-user characteristics, features of off-grid lighting systems and appropriate distribution, sales, and marketing and service channels.)	Outcome • At least 6 of manufacturers entering market in relevant countries (increase) • At least 12 of alternative products available in the market • Performance quality of products available in the market meet government criteria or independent certification entity • Consumer acceptance of modern lighting products available in the market	• Program records • surveys of market participants to identify new actors or deployment of new technology • Product surveys to determine availability, price, performance	• Firms will enter the market once informational barriers are overcome • Firms will invest in product development and distribution and marketing • Project market research and field tests will accurately represent market needs and consumer preferences • Willingness of distributors to accept new product lines
Component Objective 2: To lower barriers to end-user demand (To do this, the project will stimulate introduction of lower price point products, increase sales volumes through market aggregation instruments thus reducing unit costs, stimulate competitive price pressures, mobilize consumer and retailer financing where necessary, establish product certification mechanisms to protect against market-spoiling, and provide end-user education)	Outcome • 190,000 WLED or other non-fuel other units purchased on average per year over 10 years (assumes $25/product) • # of service personnel within local population for non-user serviceable product • If product financing is necessary, increase sources of financing by at least 2 new product offerings in the market • Product unit price for different levels of product performance categories. Target price for lowest income segment to be maximum $25	• Program records • Secondary sources reporting on market trends • Market surveys at retail level. • Consumer surveys. • Sales data from manufacturers and distributors and retailers.	• Customer demand for lighting products is very high • Prices will be low enough to enable the customer switch to higher quality lights • Fossil fuel alternative does not become heavily subsidized • Product will be of high quality in terms of durability & brightness than existing product • “Hire-purchase” concept will work for a consumer good where people have low cash incomes, if consumer finance is required
Component Objective 3: Ensure long-term sustainability of the market by establishing a thriving commercial market for modern lighting; includes capacity building within the market to design, produce, supply and service high quality and affordable products.	Outcome	• Program Records • Secondary Sources • Market assessment, including survey of product availability in market and survey of trade allies	• Same as above.

Objectives	Performance Indicators	Data Sources	Assumptions
Component 1 Output	• 10 MOUs signed with industry representatives; • Background market assessment provided to industry; • Feedback from industry influences program offerings and approach • Results report on field tests – technology requirements of mrkt/ product features • Map of distribution channels • On-the ground support provided to at least 5 international companies and 10 local companies – matchmaking. • Based on industry input, and market need, provide: consumer info., product certification, mobilize consumer and retailer finance • Key stakeholders and policymakers participate in 8 of meetings and Program Advisory Committee (indicates buy-in)	• Program Records •	• Private sector funds, donor & IFC/ staff & resources will be adequate to get these outputs, and market conditions
Component 2 Output	• Consumer education campaign products – at least 250,000 of consumers reached • Loan or partial guarantees issued • Other real financial assistance offered firms or FIs • 1000 consumers participate in field test total, including participation in each target market	• Program Records • Consumer survey	• See above
Component 3 Output	• At least 8 of meetings with key stakeholders	• Program Records	• See above

Objectives	Performance Indicators	Data Sources	Assumptions
Component 1 Input /Activities	• Convene at least 1 meeting of global WLED industry • Enter into at least 10 MOUs to define cooperation in target mrkts w/at least 10 companies • Field test/ research , interviews, business model advisory to international co.s – at least 10 co.s supported • Mapping distribution channels • Provide comprehensive market info support re: 1. consumer product preferences, 2.distribution channels • Matchmaking services for suppliers, manufacturers, distributors, financiers	• Program Records • Industry survey & trade ally interviews • Market studies	• Resources are available from GEF/IFC & others • International and local companies interested • Companies provide a diverse range of product types for field tests
Component 2 Input/Activities	• Customer education campaigns • Product quality control and information • consumer finance, if needed • Field test of at least 3 product configurations executed in at least 1000 homes – to determine consumer needs.	• Same as above	• End-users willing to participate in field tests. • End-users participate in focus groups and surveys •
Component 3 Input/Activities	• Support for local industry, including, as necessary: manufacture, service, sales, finance • Build political constituency to support WLED substitution for fuel – education, policy advocacy.	• Same as above.	• Policy environment which is welcoming to new technology solutions • Opposition from fuel-based businesses can be overcome thru new opportunities and education

Annex C: Photos From Target Markets

(Sent separately as pdf file)

Annex D: List of Meetings in Africa During Pre -Appraisal

1	Associated Battery Manufacturers, ABM (East Africa) Limited	26	K-Rep Bank	51	Ghana Microfinance Institutions Network (GHAMFIN)
2	Bright Home Solar Energy	27	Mabati Rolling Mills, Ltd.	52	Ghana Co -Operative Credit Unions Association (CUA) Ltd.
3	Celtel	28	Moi University, Dept of Physics	53	Support Programme for Enterprise Empowerment and Development (SPEED)
4	Center for Environment and Renewable Energy Studies (CERES)	29	National Bureau of Statistics	54	Ghana Minist ry of Energy
5	Chloride Exide	30	Practical Action (formerly ITDG)	55	Ghana Energy Foundation
6	Coca Cola	31	Safaricom	56	Millennium Challenge Corporation
7	Coca Cola	32	Sangyug Enterprises LTD	57	USAID Ghana
8	Dar Es Salaam Scientific Limited	33	Small Industrial Development Organization (SIDO)	58	Technoserve, Ghana
9	Department of Health, Tanzania	34	Sollatek	59	Ghana Ministry of Environment & Science
10	ENEA Electronic Arts	35	Solux Lantern	60	OneTouch, Ghana Telecom
11	Energy for Sustainable Develo pment (ESD)	36	Suntopway Solar (Uganda) Ltd	61	United Nations Development Programme
12	ETC Foundation	37	Sustainable Energy & Environment Enterprises Company (SEEECo)	62	Japan International Cooperation Agency (JICA)
13	Eveready East Africa, Ltd.	38	Tanganyika Christain Refugee Service	63	Department for International Development (DFID)
14	FREDEKA	39	Tanzania Brewing Company	64	Global Environment Facility Small Grants Programme
15	Frigoken LTD	40	Tanzania Solar Energy Association (TASEA)	65	Sollatek Ghana Ltd
16	Gulf Africa Petroleum Corporation (GAPCO)	41	Tanzania Traditional Energy Development and Environment Organization	66	Solar Light Co.
17	Honeycare	42	Tunakopesha Limited	67	DENG Limited
18	Integral Advisory Limited / Photovolttaic Market Transfomation Initiative (PVMTI)	43	Umeme Jua Ltd.	68	Dizengoff Ghana Ltd
19	Kenital	44	Unilever Tea East Africa	69	Wise Energy Ltd
20	Kenya Ministry of Trade and Industry	45	United Nations Development Programme	70	Kwame Nkrumah University of Science and Techno logy (KNUST)
21	Kenya Renewable Energy Association	46	United Nations High Commissioner for Refugees (UNHCR)	71	Technical Systems Ltd
22	Kenya Solar Energy Association (Solarnet)	47	White Sands Hotel & Resort	72	Rural Agenda Initiative & Network (RAIN)
23	Kenya Solar Technicians Association	48	APEX Association of Rural Banks	73	Wilkins Engineering
24	Kumasi Institute of Technology and Environment (KITE)	49	Institute of Industrial Research (Council for Scientific and Industrial Research)		
	Kickstart	50	The Poly Group (distributors for LG)		

Annex E: Indicative Field Test Plan

This annex describes a work plan and methodology for the local performance of field tests in off-grid areas of Africa. The objective of this work is to quantify and describe the primary lighting applications that exist in the program countries and to test the performance of six to eight commercially available efficient lighting products. The outcome shall be a report of the field study, recommendations for the types of products that could meet the needs of the users, and a set of performance specifications that must be met by products offered by manufacturers seeking to participate in the program.

Defining the Target Groups

Based on the IFC team's visits to Ghana, Kenya and Tanzania, and previous experiences of the team members in other developing countries, the target groups for the field test are retail vendors, households and temporary shelters for refugees. Each of these target groups presently uses a variety of fuel-based lighting and would benefit in many respects from using energy efficient, modern lighting technologies. Field tests for at least two target groups shall be conducted in each country participating in the program, for a minimum of six field tests. Each test shall be repeated in at least 10 vendor stations, 10 households, or 10 temporary shelters.

Human Resource Requirements

The protocols, report formats and specification outlines for the field tests shall be drafted by IFC technical consultants. IFC or its designated in-country program administrator shall issue a Request for Proposals including these materials to local parties which are qualified to conduct lighting audits and evaluations. Capable organizations could include non-governmental organizations, university researchers, healthcare outreach programs, independent energy auditors or other consultant teams with prior experience in quantitative and human factors field work and data gathering. The teams must be familiar with common scientific observation and recording methods (including basic photography) and be able to use measurement instruments. One team member shall be designated as field test coordinator for all of the teams. The coordinator shall be responsible for communicating with the teams, and also with the program administrator (or IFC technical consultant). This coordinator must have experience in training or teaching in a science-related discipline. (A bachelor's degree or equivalent is preferred, plus at least three years of project management experience.)

Each country could have one team; or, multi-national teams are acceptable, too. All teams shall attend a training session conducted by the field test coordinator, and shall work together to practice the field testing protocol and data recording. The coordinator's training and preparation time prior to field work is estimated to be two weeks effort for one or two persons. Each team member will spend three days in a group training session. After this session the teams will select locations and sites for their field test measurements. Each team should have three members who could work in the field for a period of two weeks. One person would act as a liaison, one person would use the measurement instruments, and the third person would record data. Team members should be well-organized, able to write and to work with numbers. (A high-school diploma or equivalent is preferred.) Data analysis and report writing is estimated to be one month for one person per team, and two weeks for one person to combine the individual teams' reports.

The reports shall be written in English and shall contain: individual data sheets for each site; summary data sheets for each application; narrative describing the method used and any problems or unusual circumstances encountered; photographs of the sites; qualitative and quantitative description of the base case situations; qualitative and quantitative evaluation of the products tested; desirable performance parameters for future products, in the form of a performance specification; discussion and conclusions.

The draft report shall be reviewed by the program administrator and by the IFC technical consultant. Upon approval, the report shall be released publicly, and the specifications forwarded to a third party certification organization, such as the Efficient Lighting Initiative Quality Certification Institute or a similar body that shall publish the specifications and administer an application process for product qualification.

The effort is expected to have a duration of 4-8 months after the selection of the coordinator and the teams.

High Level/Indicative Work Plan

Task/ Month	1	2	3	4	5	6
Issue RFP & select team	X	X				
Negotiate contracts and SOW		X				
Prepare and conduct training		X	X			
Select sites and conduct field tests			X	X		
Write team reports					X	
Draft final report					X	X
Publication of specifications						X

The following narrative is an example of how a field test would be conducted for retail vendor or residential lighting applications. If field tests are conducted in temporary shelters another similar protocol will be developed prior to the RFP. In this narrative the products for testing are referred to as "WLED lights," but they could be any modern, efficient technology, such as compact fluorescent lamps.

Field Test Protocol

Goal
To observe, describe and record situations in which fuel-based lighting (diesel, kerosene, oil or paraffin) could potentially be replaced by solid-state lighting that uses light emitting diodes (WLEDs). This is not meant to be a statistically representative sample of any data, rather, it is an initial survey of the lighting conditions presently found in two situations: 1) vendors or retail shops in market settings; 2) residences.

Strategy
Gather information that will enable the team to describe both qualitatively and quantitatively the most common luminous (direct view of the light source) and illumination (reflected light) applications. Summarize the observed and expressed needs of the local users. The team will use this information to suggest several promising applications and to begin to develop performance specifications for generic types of WLED lighting systems. The team will also use any data on numbers of light sources and

volumes of fuels to attempt to estimate the energy, financial and environmental benefits of introducing WLED lighting systems.

Objectives
Identify technologies presently in use. Conduct visual audits of numbers and types of light sources, and volume and price of fuels. Establish baseline illuminance for common tasks. If possible, demonstrate, compare and simply evaluate the performance of a few WLED lighting devices.

Equipment and Materials
- Video camera.
- Digital camera (with "night photos" option).
- Digital audio recorder (optional).
- Illuminance meter.
- Black tube for converting the illuminance meter to a luminance meter (optional). Sketchpad or notebook.
- Graph paper or templates.
- Pens and pencils.
- 2-meter "string."
- Tape measure.
- Meter-square black, opaque cloth, marked off in a grid of 0.2-meter increments.
- Dark clothing for the person who uses the illuminance meter.

Documentation
The observer should conduct the following tasks while the other team member conducts an interview with the site host, and records this person's name and mailing and email addresses. Repeatedly reassure the host and the occupants that you are just curious about the lighting in their space… *do not make any evaluative statements about the lighting situation*. It's not "good," or "bad," it's "interesting." You are only observing the present situation so that you can discuss it with your colleagues and describe it to manufacturers. If you make evaluative statements, you could easily skew the comments of the occupants[1].

First,
- Record date, time of day, location and type of building.
- Photograph or videotape the general situation, and then photograph people at their tasks, if possible. Otherwise, photograph the light sources in the positions in which they are normally used. This can be done at any hour, and will probably provide the most useful information if done during the day or just at twilight as lights are being introduced. (See note regarding permissions[2].)

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[1] Unfortunately, many people hold beliefs about lighting that are false. Many do not understand how remarkably adaptable our eyes can be… or know that as our eyes age we need more light in order to see fine threshold tasks, like reading. Also, some people believe that low light levels can "ruin" vision… but this is not usually the case at all; more often people need corrective lenses, or they suffer from diseases or poor nutrition that damaged their visual systems. It's likely that the team will hear some of these beliefs expressed but it's best just to listen, and not to agree or disagree unless you are confident that you have scientific basis to do so.

[2] PHOTOGRAPHY CAUTION: ***Always ask permission*** before photographing anyone, especially women and children. It is common practice for photographers to also ask permission to reproduce or show these images later; if possible, obtain a simple written consent. In return, it is also common to offer to send a set of prints to the people you photographed. Or, in some cases it is appropriate to pay, or make a donation to the organization. Most intellectual property laws establish that an individual has the rights to their own image unless they explicitly grant permission or a license to the photographer. In some cultures, "taking" a picture is thought to take something intangible away from the person, or to intrude upon their private being or their social status.

- Note any supports, hangars, fasteners, stands or other means of attaching or holding light sources. If there is a on-site power generation system (diesel generator, PV panels, etc.) also note the type of inverters, transformers, and the current (AC or DC), volts and amps provided by the supply, as well as any cables, connectors, outlets, or other infrastructure.
- Describe the type(s) and count and record the number of light sources per a reasonable unit of space. For example, count how many light bulbs are on a string over each shop stall in the market, or how many lanterns are in each room of a multifamily lodging.
- Estimate the volume of fuel for each light source, or the capacity of the power supply (liters of diesel or oil, or size, type, number and output of solar panels).

Next…

- Minimize your interaction with people until this general documentation is complete.
- Observe and describe people's common activities conducted in and around building, preferably during dark hours, or at least in interior spaces without abundant daylight. Try to take representative photos.
- Note the age of the people. How far are each person's eyes from the task that they are trying to do? For example, if children are studying, are they looking at a blackboard 5 meters distant, or, are they holding a book close to their face?

Finally, if the situation is amenable, try to measure some baseline illuminances. (This is a great way to have people onsite participate.) One team member should record data points and comments while the other team member positions and uses the cloth, string and illuminance meter. It's slow and difficult to do both the measurement and recording alone!

Set-up and Protocol for Measurements

Generally, we are trying to establish a quantitative baseline for both vertical and horizontal illuminance in the geometric planes that are most critical for task performance. Also, if time permits, it will be useful to have a few measurements of the illuminance on walls, at eye level of the typical room occupant, and perhaps on ceilings (if the team becomes very ambitious!).

[We have prepared a template for recording measurements, but you could also make your own. Just use whatever is most consistent and efficient for the team.]

Choose the plane that seems most task-critical.

For horizontal illuminance,

- The lintel or steps to the doorway if this is where a lamp is typically positioned.
- A bench or table where food is prepared or items are assembled or sorted.
- A desk or other writing surface used by the teacher and students in a classroom.
- The treatment tables in a medical center.
- A footstool or block or bench on the floor where someone may be reading or eating.
-

For vertical illuminance,

- Items on shelves, such as medicines, books, tools or other small objects that must be differentiated by the user.
- Blackboards or notice boards (perhaps where lists of patients are posted in a clinic).
- Locations where it is important to recognize facial features, such as at the entrance to a room, the "bargaining spot" in a retail stall, seated for an interview or examination in a clinic, and at eyelevel during social interactions, like eating communally.

Measurement Methods
The basic tools are the string, the tape measure, the square meter cloth and the illuminance meter. The observer should wear a long-sleeve black shirt to avoid reflecting light onto the illuminance meter's sensor.

Start by making a rough sketch of the geometry of the space, indicating the sizes and 3-D positions of the light sources; include any windows or doorways.

Using the string or tape, note the distance from the light source to the surface that you are going to measure. Also note the distance from the light source to the position of the person(s) who would be conducting tasks. Indicate which direction the person(s) usually face.

Illuminance
For horizontal illuminance, we want to determine the distribution of light across the surface that is most critical for the tasks.

- If the room is large or there are distinct task areas within the room and the illuminance distribution appears to vary significantly, select several areas to measure.
- The entire task surface need not be measured if the light source is positioned symmetrically with respect to the surface. In this case, those points within a quarter or half of the critical surface area should be measured.
- If there's enough room on the surface, it's best to lay out the entire cloth to avoid light spilling into the area being measured, rather than folding the cloth in half or quarters.
- Take a photograph of the set-up, preferably with a person in the typical task orientation. For the photo, lay the white tape measure across the surface.
- Remove the tape measure. Position the sensor head on each point. (The data reader should take care to step out of the path of the light!) Pull your hand away and wait 15 seconds before noting the illuminance data, calling it out for the other team member to record. Repeat this procedure for each data point on the cloth.

For vertical illuminance, we usually only need a few points along a line that is at eye-level. However, if people use the space both for tasks conducted while sitting level and while standing, measure along a line at each height.

- Have the participants hold the cloth against a wall, or suspended in a position where tasks are conducted.
- Adjust the height of the cloth until an interior row of points is at the appropriate height.
- The data observer must take care to avoid casting any shadows. Note the illuminance data for each point by calling it out to the recorder.

If time permits, and it is possible to place one or more of the sample WLED lights in a position that would give a reasonably similar (or greater) illuminance than the typical set-up with fuel lighting, then the team could conduct two experiments.

First, try to create the same illuminance and illuminance distribution on the surface that you have measured. Sketch the set-up and then measure the distance at which you must position the WLED light(s) to achieve this minimum illuminance.

Second, reposition the WLED lights until you achieve the following illuminances, if possible. Sketch the set-up and then measure the distance at which you must position the WLED light(s) to achieve this recommended illuminance[3].

Area & Task	**Horizontal Illuminance**	**Vertical Illuminance**
Classroom, general	300 lux	
Classroom, desk, pencil	300 lux	
Classroom, desk, printed	300 to 500 lux	
Classroom, blackboard		500 lux
Classroom, whiteboard		50 lux
Library book stacks		500 lux
Computer station	100 to 300 lux	30 lux
Healthcare, surgery, exam and labor rooms	3000 to 10,000 lux	300 to 500 lux
Healthcare, waiting areas	100 lux	30 lux
House of worship	100 lux	30 lux
Retail	500 lux	100 lux
Residence, kitchen	300 lux	50 lux
Residence, dining	50 lux	50 lux

* Conversion: 10 lux = 1 footcandle.

Luminance

If the illuminance meter can be adapted with a black tube to approximate a 2-degree cone of view, then it could be used for rough measurements of *luminance* ("brightness" of the light source) and *luminance contrast* (difference in brightness between the light source and its immediate surroundings).

Point the meter as accurately as possible at the center of the light source. Hold steady for 15 seconds and then take a reading. Cover the meter head for a few seconds, and then point it at the adjacent area, but NOT at the light source. Again, hold steady for 15 seconds and then take a reading. Later we can calculate the *luminance contrast ratio*. Generally, the higher the ratio, the more likely it is that viewers will experience *glare*, or even *discomfort glare* (they need to blink, or they involuntarily turn their eyes away from the light source). For example, do not shine the WLED lights into anyone's face! This will cause discomfort glare and could bias any comments the person may have about the WLEDs.

[3] Recommended illuminances from the IESNA Lighting Handbook, 9th Edition, published by Illuminating Engineering Society of North America, 2000. Mark S. Rea, ed.

Annex F: Sample of International Lighting Firms To be Invited to Join Consortium

Company	Location	Product	Brand
Bulb Manufacturers			
Thinlite	USA	CFLs, FLs, Inverters	Thinlite
Dar Es Salaam Scientific Limited	Tanzania	glassworks	
LED Manufacturers			
LEDtronics		LEDs packages and systems	
Montana Light / Light It Technologies	USA	LED Fixtures	-
Nemalux	Canada	LED Lighting, Solar Power Systems	Nemalux
Binay Opto Electronics (P) Ltd.	India	LEDs	
COTCO International Ltd.	Hong Kong	LEDs	
LumiLeds	USA	LEDs	Luxeon
Nichia Chemical Corporation	Japan	LEDs	SMD: Jupiter, Raiko & Rigel
Battery Manufacturers			
Associated Battery Manufacturers, ABM (East Africa) Limited	Kenya	Batteries	
East Penn Manufacturing Co.	PA, USA	Batteries	Deka
Surette	-	Batteries	-
Willard Batteries	SA	Batteries	-
Chloride Exide	Kenya	Batteries; solar panels	
Component Manufacturers			
ENEA Electronic Arts	Tanzania	CFL inverters	
Morningstar	USA	Controllers	-
SunWize	USA	Controllers	Steca
Outback Power Systems	USA	Inverters	Outback
Xantrex	Canada	Inverters, Controllers	Trace
Lumidrives Ltd	UK	LED drivers	
PV Manufacturers			
BP Solar	USA/Spain	PV modules	BP
GE	USA	PV modules	GE
Kyocera	Kyoto, Japan	PV modules	Kyocera
Sharp	Japan	PV modules	Sharp
Shell	South Africa	PV modules	Shell
Uni-Solar	USA	PV modules	Uni-solar

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Annex H: Response to Project Reviews

a) STAP Review

STAP Reviewer:	Daniel M. Kammen
Position:	Class of 1935 Distinguished Chair in Energy Energy and Resources Group & Goldman School of Public Policy Director, Renewable and Appropriate Energy Laboratory (RAEL) Co-Director, Berkeley Institute of the Environment (BiE) University of California
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STAP Review

Note: two of the project consultants for this effort, Professor Arne Jacobson and Ms. Rebecca Ghanadan are my current and recently graduated students (see, e.g. the listed references: Moner-Girona, et al.*, 2006, and Jacobson and Kammen, 2005).*

Some of the comment presented here grew out of both our collaborative field and analytical work on the energy markets in Eastern and Southern Africa, and our shared assessment of this project.

<u>Overall</u>:

This is an ambitious and potentially very important project, and should be supported.

The most exceptional feature of this project is the plan to develop essentially a new technology and market-base in Africa (some use of LED lighting exists, but it is very limited). The potential to develop this industry for the African market, and in a financially meaningful partnership with the global semiconductor industry has great promise, if managed truly to meet the 'bottom of the pyramid' needs. At the same time, the risk without oversight for this needy market segment to be served poorly is real. This project appears to have the needed safeguards in place, given the track-record of efforts in Africa (such as the prior IFC PVMTI program in Kenya[4]).

The focus on a new, application-specific, technology for Africa reduces (though does not eliminate) many of the complexities of interventions in existing markets. One of the greatest strengths of this project is the ability to leverage LED lighting at a relatively large scale due to the state of the international industry and the potential to meet a critical set of price and performance points that have great appeal and demand in Africa. The decision to focus on

[4] PVMTI, the Photovoltatics Markets Transformation Initiative is mentioned in the PCD, but only once (page 2). The experiences, both positive *and* negative from that effort – and from not only the large contract recipients, but also, small businesses and end users – needs to be documented and discussed in greater detail as it related in some critical ways to the efforts envisioned here.

<u>IFC Response:</u>

The lessons learned from PVMTI are implicit in the approach proposed for this Project, and discussion of this has been emphasized further in the Project Brief in response to this comment. Particular insights include: the need to engage alternative distribution channels used successfully for other product categories; the importance of a technology agnostic approach to enable the market to identify the optimal solution; and the need to target a lower price point than currently available solar solutions.

multiple countries, while challenging, is also well-taken in this context so that the market size can be increased, and so that a range of applications can be addressed.

At the same time, this arrangement leads to the two key recommendations of this review:

1. **Establish an international advisory committee, with primary membership of ministries and consumer (NGO) watchdog groups that have real oversight authority in the commercial operation in each country**. External advisors who have no commercial role in the project should also be represented on the committee. This may at first seem overly onerous, but the market potential of this partnership, and the degree to which a LED program that works as envisioned will, in effect, bind the consumers to this technology, warrant this approach. As the experience with the technology grows, and the more and less profitable market segments become clear, an oversight team will be needed to be sure that the 'Bottom of the Pyramid' approach does not in any way degenerate into a preferred push on the best-performing market segments.

   IFC Response:
   The Project design provides for the creation of three national Advisory Committees which will represent local needs. These Committees will consist of relevant government and non-governmental representatives and will meet regularly to guide the implementation of the project. In addition, the findings of each national Committee will be shared with their counterparts and all three Committees will be brought together at regular intervals to discuss the progress of the project at an international level.

2. **A more detailed market analysis that is presented in the PCD is required.** This can be done once the project is approved (as a pre-commercial assessment, but also as a baseline plan for the use of the advisory committee in evaluating project development. Aspects of this analysis could include:

   - Learning curve analysis of the technology (see, e.g. Duke and Kammen, 2003). In fact, the analysis of the amorphous silicon solar cell market potential in Africa presented in this paper could be used quite effectively in exploring what different price-points and specific products might do in the market context of these nations.
   - An analysis of technology adoption in African context (identifying priority segments), and;
   - Clearer identification of the priorities & approaches in reaching different market segments (i.e. lighting for applications across income scales).

   IFC Response:
   Step 2 of the Project's proposed 6-step implementation approach is entirely focused on market analysis with the objective of developing a detailed understanding of market segments, consumer needs and trade-offs, competitive price points, and likely adoption patterns. The reviewer's recommendations for this analysis will be incorporated into the program design.

Lighting markets in Ghana, Kenya, and Tanzania all qualify, generally, as "lighting the bottom of the pyramid" from an OECD perspective. However, the market is not at all unified, and these analyses are necessary to develop a more detailed & realistic expectations of what market support is needed (and what the environmental, fuel, and other benefits maybe).

***IFC Response**:*
Steps 2 and 3 of the Project's proposed 6-step implementation approach will assess market needs and distribution options on a country specific basis.

Finally, one significant methodological caution. The analysis presented for this project assumes lighting "displacement" *a priori*. Namely, the LED lights will offset other, incandescent purchases. It would be a more accurate understanding to think of LEDs offering high quality, relatively low cost lighting that *may* displace/substitute or add to existing lighting options to African end-users.

While the distinction makes a difference for assumptions about GHG offsets, it does not make a difference for the claim that LEDs certainly improve upon people's existing lighting options in Africa. It is non-trivial to recognize this difference because the GHG benefits of PV in Africa have been commonly emphasized in the literature, often because of the need to meet incremental cost goals when other objectives (employment, service provision, security, quality of life) are also part of the goal set.

***IFC Response**:*
The Project's methodology assumes market penetration and energy savings articulated as fractions of total lighting energy, as opposed to numbers of households or light sources. It is important to note that the potential for lighting-related CO_2 *reductions from traditional whole-house solar electric systems have been curbed (Hankins 2005) in part by the limited efficacy of traditional fluorescent lighting used therein, and end-users sometimes prefer to use scarce solar electricity for other end uses (e.g. television). Consequently, among relatively affluent households, the introduction of alternative lighting may be taken as an augmentation to existing lighting rather than as a substitute (as has been observed for current solar home systems) and thus could result in little if any reduction in energy user or associated emissions. We believe that for our target market this "take-back effect" will be limited, and virtually non-existent in the case of single-vendor night-market businesses or the poorest households (which use only one light source and can barely afford the kerosene they use today). We believe that the proposed technology will be significantly more successful than conventional solar lighting because: (i) it will provide more effective lighting at lower cost than the alternative; (ii) it will be targeted at lower income households which are more likely to take the solar light as a substitute to (rather than augmentation of) existing kerosene, and (iii) it will make possible more than one affordable point of light for a given consumer.*

Aspects Needing Particular Attention:
As stated above a concern is that the project document treats the market as a single entity and thus not specific enough about market development and blurring opportunities/constraints, costs/benefits across different applications and groups. A clearer market analysis framework (even if it spells out where uncertainties) would make it possible to begin to talk about priorities, barriers, and needs of different market segments as separate entities. That is, what is the composition of the market pyramid within Kenya, Tanzania, Ghana? This would be a valuable contribution to the "bottom of the pyramid" literature and will be critical to successful project implementation.

End use analysis and product development will need to be geared differently to different groups. And talking concretely about segments will also lead to more appropriate assessments. End user needs, applications, ability to pay, distribution channels, and potential GHG/environmental benefits will all be highly specific to different market segments. One can envision an approach needing to develop different approaches for i) small business applications & urban backup applications, ii) peri-urban & rural middle class, and iii) rural non-middle class. As stated in the overall comments, this need not be completed prior to project approval, but should be planned and budgeted into the overall effort. The advisory committee could, again, be a natural recipient of the analysis.

One of the most important contributions of a highly leveraged project like this is its potential to exploit all avenues for bringing prices for LED lighting technologies down. This may be via standard learning curve demand (though likely small in global context). But more likely in catalyzing many of the specific market "innovations" needed to make prices and technologies fit lighting needs and purchasing power capabilities in Africa. It would be ideal to include a more explicit analysis of what the learning curve potential is for LED lighting over the next 5 years or so.

From a business and service perspective, it would also make sense to commission an explicit analysis of what are the key factors keeping efficient lighting technologies costly in Africa, and how this project will directly go about reducing them (i.e. are they a result of import duties, wholesale or distribution surpluses, small quantity purchases, transportation, etc). In the case of the Kenyan solar market, the evaluation and presentation back to the Office of the Vice President of the size and impact of import tariffs, was particularly important in subsequent government decision—making (Duke, *et al*, 2002; Jacobson and Kammen, 2005)

***IFC Response**:*
Steps 2 and 3 of the Project's proposed 6-step implementation approach will assess market needs and distribution options on a country specific basis. Step 2 is entirely focused on market analysis with the objective of developing a detailed understanding of market segments, consumer needs and trade-offs, competitive price points, and likely adoption patterns. The reviewer's recommendations for inclusion of analysis on why current technologies remain expensive and the potential for learning-curve benefits in WLED-based technology analysis will be incorporated into program design.

Specific Comments:
The economic analysis needs to be expanded. Technology penetration rates are a) not likely to all be so simple or similar, and b) there needs to be more analysis of the different services provided to different socioeconomic segments. Again, this task, if done properly, is a large effort, and could be formulated as a pre-feasibility effort to look at a range of technology entry points.

As well formulated by Prof. Jacobson:

> At the "entry level" of the spectrum will be stand-alone light sources (usable individually or in multiples) at price points in the vicinity of US$5 each. In practice, lights of different sizes (light output) would be offered, ranging from 0.1 to 1.0 Watts, and perhaps higher for specialized applications, with a range in prices for perhaps $2 to $10 each. These will be powered by removable "AA" style (or similar) batteries, already available in the local market. In this configuration, either disposable batteries at $0.25 each (lower first cost and

higher operation cost) will be used, or rechargeable batteries at ~$1.50 each charged by local micro-enterprises using solar photovoltaic or grid-based charging at a cost of perhaps $0.10 per charge. Alternatively, third parties may elect to establish micro-grids with central power at the scale of a cluster of homes or greater. Consumers can graduate from disposable to rechargeable batteries or microgrids as they become able to afford third-party recharging or their own charging device. The next step upwards will be to stand-alone systems with integrated charging (PV, hand cranked, etc). These systems would be modular in that they could be purchased incrementally (e.g. Charger ~$15-$20) plus one or more light points at perhaps $5 each. Lastly would be relatively high-end configurations including a package with multiple light sources, charging, and even ancillary services such as cell phone or radio power. These would be valued more highly, e.g. because they would defer phone charging costs of ~$10/month) and would be brought to the market at a correspondingly higher price point.

IFC Response:
This characterization of the market opportunities and nuances has been integrated in our proposal. The economic analysis will be refined during the appraisal process and throughout the Project life as the understanding of each specific market is improved. The needs and potential penetration rates of each market segment in each country will be key data points provided to the private sector consortium and will enable them to develop products and market entry strategies which suit demand.

The job creation potential of this project – a major benefit -- is under-emphasized and should be given much more attention. While a GEF proposal requires attention to environmental benefits, development benefits are equally (if not more) significant. The proposal discusses in a short section the possibility of local manufacture, however with a strong caveat of only doing this if it makes sense in "least cost terms".

The potential exists here to make job creation as a more explicit goal. To support the potential of local manufacture, a cost comparison analysis is in order. This area seems a large area of potential untapped benefits (and challenges) not highlighted in the proposal.

IFC Response:
Project design has been carefully structured to provide an intervention that enables but does not distort a sustainable market response. To this end, careful economic cost-benefit analysis will be provided to the private sector consortium to ensure that it gives appropriate consideration to the potential for local manufacture and makes an optimal decision when locating its manufacturing facilities.

Page 2, remove, 'young juggernaut of the solid-state lighting industry' phrase.

IFC Response:
Suggestion incorporated into submission.

Figure 6: should not be included in the PCD. This is part of a report my doctoral student Rebecca Ghanadan, who provided input to the project in writing for the World Bank. It has not been published at this time and the figure is not attributed properly to Ms. Ghanadan.

***IFC Response*:**
Suggestion incorporated into submission.

References:

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b) GEF Secretariat Review

GEF Review Sheet of Project Concept Note
January 13, 2006
Program Manager: Zhihong Zhang
Requested Project Information by Work Program Inclusion

1. **Endorsement letters from the participating countries will be required**

IFC Comments: Endorsement letters received from Ghana and Kenya.

2. **Countries and markets are specified, including the number of people/households who will make the switch from fuel-based to modern lighting. Direct and indirect GHG emissions reduction is estimated as a result of the project.**

IFC Comments: IFC selected Ghana and Kenya for Project implementation. Three (3) scenarios have been developed for market penetration by WLED-based lighting products and resulting GHG emission reductions. A detailed description of the selection process and assumptions behind IFC market estimates can be found, respectively in Section 3 (Country Selection) and Annex A (Incremental Cost Analysis).

3. **Markets for replication are identified and activities planned.**

IFC Comments: The Project Brief describes the global nature of the fuel-based lighting problem that the Project is trying to address and the large potential for replication in other developing countries, most of which have similar conditions to Ghana and Kenya. These commonalities include (i) a significant proportion of the population lacking access to the

grid, (ii) extensive reliance of this population on fuel-based lighting, (iii) existence of alternative product distribution channels, and (iv) an investment climate which does not deter interest and engagement by the international private sector.
As part of its strategy for replication, IFC has:

- Selected 2 countries that account for 10% of the total non-electrified population in Sub-Saharan Africa and almost 1% of the global non-electrified population. This provides sufficient scale to validate the project approach for address this global problem; and
- Designed a market-focused project that positions the private sector to play the leading role in developing a new market for WLED-based lighting products. The benefit of this approach is that once the private sector validates the market opportunity in the target countries, it will automatically seek to expand into additional markets, requiring limited or no further IFC/GEF support.

For further details, please refer to Section 4 (Strategic Context and Project Rationale) and Section 9 (Sustainability and Replicability)

4. Document the involvement of the local key stakeholders (local governments, end-users, industry, etc.)

IFC Comments: IFC has undertaken an extensive consultation process in preparing the Project. This has strongly influenced the Project design and ensured focus on key barriers. Consultations include discussions with 50 international WLED companies and over 70 meetings with local stakeholders in candidate countries. For a detailed documentation of those consultations, please refer to Section 4.5: Project Rationale, which discusses how those consultations influenced the project design, Section 6: Stakeholder Participation, Annex D: List of Meetings with Stakeholders, and Annex F (Sample of International Lighting Firms To be Invited to Join Consortium).

5. Sources of co-financing are specified.

IFC Comments: IFC describes in the Project Brief both the sources of co-financing (donors and IFC), and the sources of leverage (private sector and end-users). Based on its experience with similar market transformation projects, IFC believes the project will be able to leverage a very significant level of resources from the private sector and end-users. For more detailed discussion please refer to Section 8: Project Budget, Financial Modalities, Financial Plan and Cost Effectiveness.

6. Document collaboration with ESMAP and other partners.

IFC Comments: IFC has discussed collaboration with several partners, including other multilaterals, international initiatives such as GVEP, and local NGOs in each of the target countries. In particular, IFC has discussed collaboration with (i) ESMAP concerning its DFID-funded program for SMEs in Africa, and (ii) IBRD concerning its project in Ghana also seeking GEF funding. IFC has identified many potential areas of collaboration and synergies between these initiatives and will be pursuing those during implementation.

Further, during pre-appraisal IFC has undertaken an extensive review of between 10 and 17 existing initiatives in each of the target countries seeking to bring modern energy services to non-electrified populations. IFC will seek areas of collaboration with selected existing initiatives as appropriate for the project. For details on our efforts on collaboration, please refer to Section 7.6 (Institutional Coordination and Support).

GEF Review Sheet of Project Brief
April 13, 2006
Program Manager: Zhihong Zhang
Requested Project Information by Work Program Inclusion

IFC responses to the comments from the GEF Secretariat on the Project Brief for the Project "Lighting the Bottom of the Pyramid". A summary table is provided below and the remainder of this document provides more detailed responses to GEF questions/comments.

SUMMARY OF RESPONSES

GEF Question/Comment	IFC Response
1. Identify and address barriers for consumer adoption of new technologies	The project design has identified key consumer barriers, such as high cost and low affordability, mismatch between product design and end-user needs and lack of information. The project encompasses specific actions to remove those barriers, such as focusing on more affordable WLEDS, mobilizing micro-lending as necessary, ensuring proper product design and promoting consumer awareness campaigns.
2. Need to clarify use of $3.5MM of GEF funds for Step 5	IFC has set 6 main actions planned for those funds. IFC has provided a tentative language to avoid pre-determining actions to be taken 3-4 years from the start of the project, ensure the project retains the necessary flexibility to respond to the evolving market conditions. During appraisal IFC will refine its estimates and will further consult with GEF.
3. Need to clarify assumptions and methodology for CO2 reduction calculations	A preliminary summary that aims to offer additional details is provided in Annex A
4. Need specific targets for performance indicators in the logframe	Preliminary targets included (see preliminary list on Annex B). During appraisal IFC will further refine indicators and targets.
5. Document collaboration with ESMAP and other partners	IFC has consulted with ESMAP and a number of other partners, both international and local , to explore collaboration opportunities. See Project Brief on page 37 for details.
6. Explain reduction of co-financing from $12-30MM to $6.75MM	Co-financing has not fallen but has been to large extent are-categorized as leverage. In fact, the project has increased the total resources from 3rd parties raised for the project from $ 12-30MM to $78MM
7. Market penetration of 10% seems too ambitious	IFC agrees it is an ambitious target, but notes it aimed at setting a target that sets a credible, large scale and lasting market transformation and consider a 10-year period. During appraisal IFC will be refining its market penetration estimates but WLEDs market penetration by the end of the project is likely to be around 4-5%.
8. Need for separate M&E budget	IFC set $300,000 for M&E. It will integrate more clearly the M&E budget in the total budget.

DETAILED RESPONSES

1. **On GEF's suggestion that barriers for consumer adoption of new technologies also be identified and addressed as part of the project design.**

IFC fully agrees on the importance on incorporating the customer's perspective for the adoption of new technologies. Building on previous project experiences, literature and its pre-appraisal process, IFC has identified in the project design key barriers to consumer's adoption of new technologies, including (i) high product cost and limited affordability, (ii) mismatch between product design and consumer needs, (iii) lack of information on the benefits of new products and (iv) challenges around distribution and post-service sales. To address these barriers, IFC has:

- Included in the project design actions to overcome known barriers for consumer adoption of new technologies, such a (i) mobilizing micro-lending as necessary, (ii) performing a comprehensive consumer research, and product testing to ensure WLED products are designed to meet consumer needs, (iii) promoting consumer awareness campaigns, and (vi) mapping a range of distribution channels to ensure products are delivered and serviced properly, and
- Retained for the final part of the project (Step 5) sufficient flexibility to respond with a range of actions to new or unanticipated barriers for consumer adoption of WLED that may be found during the course of the project.

Importantly, IFC's focus on WLED-based lighting solutions derives from the first-cost barrier which greatly constrained development of a robust solar home system (SHS) market. In large part because of the affordability issue, SHS's have not penetrated beyond the wealthier segments in Africa. Stand-alone WLED lighting systems provide an opportunity to penetrate this market through systems ranging from $25-$100, versus typical SHS cost of $600-$1,000.

2. **On the fact that Step 5 calls for $3.5MM of GEF funds, but lacks clarity concerning the actions to undertaken and how GEF funds will be used**

Based on previous experiences with market transformation projects, IFC believes that it will have to engage in several fronts to build the necessary institutions to support the long-term development of WLED markets. As discussed in the Project Brief, IFC's envisions undertaking 6 main actions during Step 5, namely (i) Support and Mobilizing Financing, (ii) Assessing the Potential for Local Manufacturing/Assembly, (iii) Aggregated purchasing, (iv) Performance and Quality Assurance, (v) Raising End-user Awareness, and (vi) Pro-actively Managing Solid Waste from Batteries. IFC has provided a total cost estimate of $3.5 MM based on previous experiences as it found that a detailed budget for each activity would be premature as market conditions, and the required intervention, will vary during the course of the project. Experience shows that IFC will likely have to emphasize some of the aforementioned actions while deemphasizing others, and probably add or drop one or two actions. Hence, IFC language did not mean to be cautious but to reflect the need to plan some key actions while remaining able to rapidly adapt the project actions when market conditions change. Should GEF Sec require, IFC can during appraisal develop some indicative numbers per action under Step 5, as well can have a specific consultation with GEF Sec by the end of Step 4 to discuss the envisioned actions for Step 5.

3. **On the request for a clearer explanation of the key assumptions and the method for calculating CO2 emissions reduction.**

IFC will review and incorporate in the Project Brief a summary of the Incremental Cost Analysis assumptions and methodology. A preliminary summary is provided in Annex A of this document.

4. **On the need to provide specific targets for each of the indicators in the logframe.**

IFC will review the logframe to include specific targets. A preliminary review is provided on Annex B of this document. Further refinement of targets will be developed during appraisal.

5. On collaboration with ESMAP and other partners

IFC has consulted with a number of international and local partners to explore opportunities for collaboration. Please refer to page 37 of Project Brief. Should GEF require additional information on that, IFC will be pleased to provide it.

6. On the drop in co-financing from $12-30MM (Concept Note) to $6.75MM (Project Brief) and GEF's request for a proportional reduction of GEF funds.

IFC estimate for co-financing was not reduced but re-categorized. At the concept level, IFC estimates were based on a preliminary assessment of 3rd party resources IFC anticipated raising for the project. At that stage, IFC did not differentiate between co-financing and leverage, and aimed only at ensuring that realistically the project would raise enough 3rd party resources to meet minimum GEF requirements. In the preparation of the Project Brief, IFC developed a much more detailed evaluation of the amount of 3rd party resources that IFC could raise, and if those would fall into the "co-financing" or "leverage" category according to GEF definitions. The total amount of resources IFC envisions raising, both as co-financing and leverage, has indeed increase substantially from the Concept Note to the Project Brief, from $12-30MM to $78MM. IFC reckons that the requested GEF financing of $6MM is the minimum necessary to ensure an appropriate implementation and management of the project as envisioned to create the market impact projected.

7. **On the fact that the project's base case market penetration for WLEDs – at 10% - could be too ambitious.**

IFC recognizes the challenge for a new technology to reach a 10% market penetration. Yet IFC has opted for targeting what it reckons to be the necessary level of penetration if a credible lasting market transformation is to be achieved. Based on that target, IFC then planned the appropriate level of resources and set the key settings of the project design, such as creating a strong sense of competition amongst WLED companies. The goal is to have a realistic target, but deliberately test a more aggressive and large-scale market transformation model. This target, however, should be seen as indicative and over a 10-year period, based on the preliminary assessment performed during the pre-appraisal effort. IFC envisions reviewing and detailing its target during the appraisal process and setting specific milestones and timeframe for the market penetration by the completion of the project. Subject to further refining during appraisal, IFC would expect the market penetration by the end of the project to be around 4-5%.

8. On the need for a separate M&E budget and for its integration into the project budget.

IFC has budgeted $300,000 for an independent evaluator to monitor and evaluate the project (see page 48 of Project Brief). IFC will provide a detailed budget for M&E and integrate it in the overall project budget.

GEF Requests on Bilaterals on May 19,2006
IFC Summary of Changes in the Document

GEF Question/Comment	Changes in Document	Doc Section
9. Identify and address barriers for consumer adoption of new technologies	Language included to further stress that barrier identified affect not only suppliers, but also consumer's adoption of new technologies	Section 4.5.4 of Project Brief. Also included in Executive Summa ry
10. Need to clarify use of $3.5MM of GEF funds for Step 5	Language included clarifying use of GEF funds under Step 5	Section 8 of Project Brief
11. Need to clarify assumptions and methodology for CO2 reduction calculations	Summary of assumption and methodology included	See ICA in Project Brief. Also included in Executive Summary
12. Need specific targets for performance indicators in the logframe	Specific targets included	See Annex on Logframe. Also included in Executive Summary.
13. Document collaboration with ESMAP and other partners	Documented in Project Brief	Section 7.6 of Project Brief
14. Explain reduction of co-financing from $12-30MM to $6.75MM	Explained on bilaterals. See Annex on IFC response to GEF SEC Review Sheet on Project Brief	Annex H
15. Market penetration of 10% seems too ambitious	Explained on bilaterals. See Annex on IFC response to GEF SEC Review Sheet on Project Brief	Annex H
16. Need for separate M&E budget	Included budget line specific to M&E	See Figure 16