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# Lighting Asia: Solar Off-Grid Lighting

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MINISTERO DELL'AMBIENTE  
E DELLA TUTELA DEL TERRITORIO E DEL MARE

MARKET ANALYSIS OF:  
INDIA, BANGLADESH, NEPAL, PAKISTAN,  
INDONESIA, CAMBODIA AND PHILIPPINES



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Cover page photographs:

Children with a solar light, Cambodia (M Young)

Tailor with a solar light, India (A Jacobson)



February 2012

With nearly 800 million people living in Asia with intermittent or no access to the electrical grid, these people experience greater health risks due to unclean lighting alternatives and fewer income-generating opportunities. There is an urgent need to provide clean, sustainable and affordable lighting solutions to reduce such risks and a significant opportunity for business to provide such solutions.

This 'IFC Lighting Asia Solar Off Grid Lighting Report' provides a valuable insight into the sector potential, regulatory and business environment across seven major Asian off-grid lighting markets.

It explains critical success factors for the Asian off-grid lighting sector with details of business models, price points and market scoping information. It presents a valuable resource to active players, market practitioners and investors with a vested interest in this particular market. Since access to quality lighting has a significant positive impact on productivity, education and quality of life, this report will assist in developing the necessary activities to address these challenges.

A handwritten signature in black ink, appearing to read "Rodd Eddy", with a long, sweeping underline.

Rodd Eddy

Executive Director & Acting Chairman

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## Common abbreviations

AEPC	Alternative Energy Promotion Center
AMORE	Alliance for Mindanao Off-grid Renewable Energy
Bn	Billion
BOP	Bottom of the Pyramid
CAGR	Compounded Annual Growth Rate
CBO	Community Based Organisation
CFL	Compact fluorescent lamp
EMI	Equal Monthly Installments
ESAP	Energy Sector Assistance Program (Nepal)
FMCG	Fast Moving Consumer Goods
IEA	International Energy Agency
IDCOL	Infrastructure Development Company Limited
kWh	Kilo Watt Hour
JNNSM	Jawaharlal Nehru National Solar Mission
LaBL	Lighting a Billion Lives
LED	Light-Emitting Diode
LFL	Linear Fluorescent Lamp
MFI	Microfinance Institution
Mn	Million
MNRE	Ministry of New & Renewable Energy, India
MW	Megawatt
NGO	Non-governmental Organization
PDS	Public Distribution System
PE	Private Equity
PO	Partner Organization
PV	Photovoltaic
REF	Rural Electrification Fund
RRB	Regional Rural Bank
RPP	Rural Power Project
SHS	Solar Home Systems
SME	Small and Medium Enterprise
TERI	The Energy and Resources Institute
USD	United States Dollars
VAT	Value Added Tax
VC	Venture Capital
W / W <sub>p</sub>	Watt / Watt-Peak

## Currency exchange rates

Country	Local currency value equivalent to 1 USD
India	INR 45.9
Bangladesh	BDT 70.8
Nepal	NPR 74.4
Cambodia	Riel 4245
Indonesia	Rupiah 9123
Pakistan	PKR 85.9
Philippines	PHP 45.2

Note: The currency conversion rates listed above are derived from the average of the rates over 2010  
Source: <http://www.oanda.com/currency/historical-rates/>

## Lighting Asia

Nearly 800 million people in Asia<sup>[1]</sup> live in a state of near darkness, coping with unreliable or non-existent or no access to electricity on a daily basis. The effects on these vulnerable communities are severe. Medical and educational opportunities and services are severely constrained, health risks are heightened by unclean lighting alternatives and opportunities for income-generating activities are reduced. Many people also pay a great deal over time for paltry service offered by most fuel-based lighting. There is a great need for clean, sustainable and affordable products to bring light to these households.

Modern off-grid lighting has emerged with the ascent of solar energy, battery and LED technology and has a rapidly growing demand from those living off-grid. This report provides an overview of the off-grid lighting market in seven nations across southern Asia – India, Bangladesh, Nepal, Cambodia, Indonesia, Pakistan and the Philippines – and presents the opportunity for investors and industry players to make a real and necessary impact by serving communities without access to reliable electricity.



[1] IEA figure for 2009 (developing Asia)

## The Report

### Objectives

“Lighting Asia: Solar Off-grid Lighting” provides analysis to support the Asian off-grid lighting market by:

- Guiding enterprises: in formulating their strategy to enter / scale up in these markets.
- Assisting investors: financial institutions and regulatory authorities in understanding these markets and in identifying potential opportunities to catalyze their growth

### Scope

There is a strong demand among off-grid consumers in Asia for reliable, clean and cost-effective alternatives to fuel-based lighting, in particular the kerosene lantern. This is not “as a consequence” only of the demand for alternatives, it is also dependent on the availability of alternatives and modern off-grid lighting products are rapidly emerging as an alternative.

Modern lighting products include a range of technology but are primarily rechargeable solar off-grid lighting devices. There are several broad main product categories—portable lanterns and Solar Home Systems (SHS).

**Basic Lanterns:** Lighting products that are often designed with a similar look and feel to that of traditional kerosene lanterns and that could be used as handheld devices. These products vary greatly in performance, with a range of light output and accordingly a range of solar power ratings from 0.25-4 Watt-peak<sup>[2]</sup> (Wp)

**Multifunctional lanterns:** Covers devices such as solar lanterns and torches, which offer functions over and above lighting. A common function found in such products is mobile phone charging. Typical wattage for these products range from 4-10 Wp.

A complete inventory of these products will be covered in more detail in the section 1 “Asian Overview”.



[2] Measure of the nominal power generated by a photovoltaic energy device under laboratory conditions



A tailor in Bihar using a solar lantern (India)

Photos: A. Jacobson

In each of the seven focus countries a parallel analysis was completed to facilitate their comparison. First, the market potential was assessed by examining current expenditure on kerosene for lighting and other lighting products by the households.

The report traces the evolution of solar off-grid lighting market in these countries, the forces affecting their development and the current penetration of these products in these markets. Country-by-country market analyses focus on the following key components:

- Government and donor-driven programs to promote solar lighting
- Supply and demand characteristics and product trends
- Product consumer financing and Small and Medium Enterprise (SME) financing
- Market barriers

The report concludes with high-level opportunities for private sector enterprises to engage in this market.

# Executive Summary

## Introduction

Nearly 1.3 billion people worldwide<sup>[3]</sup>-almost a quarter of the world's population-live without access to electricity. More than half reside in Asia, where they face severe challenges to basic lighting access; 85% of off-grid Asians are in the seven focus countries of this report. India alone has 400 million people who live without the distinct advantages offered by modern lighting of any kind, about half of the continent's off-grid population. An even larger number of people in these countries are under-electrified, facing constant outages that beg for new solutions. Given the slow pace of grid expansion on the continent, this situation is expected to remain for years to come unless innovative, low-cost alternatives are introduced.

Currently, off-grid households largely depend on conventional fuel burning (mainly kerosene) that are inefficient, polluting and damaging to both health and the environment. Solar off-grid lighting alternatives offer a better cost-performance option<sup>[4]</sup> with health, safety and environmental benefits. Despite their potential, these products have yet to make a significant impact in the market. The current limitations in distribution models, the small size of market players and their inability to scale the market are among the reasons for lack of penetration. It does not help that in India and in Indonesia kerosene is heavily subsidized by the government, distorting the market for lighting.

Across countries, it is mostly SMEs and social enterprises that are currently engaging with the low-income off-grid consumers to promote solar off-grid lighting products, while larger enterprises have yet to make significant investments to serve this segment.

While purely commercial models<sup>[5]</sup> that demonstrate profitability through delivering solar off-grid lighting products exist, they are few and far between. A majority of the business models covered in the seven countries are semi-commercial, they are usually able to recover running costs but are still partially dependent on external grants and subsidies. In some countries, the solar off-grid lighting market is fully subsidized by the government, and the private sector has yet to establish businesses with significant scale and profitability.

[3] IEA (2009)

[4] From a lifecycle cost perspective

[5] No dependence on external grant / subsidized capital

An opportunity exists for investors and enterprises alike in these under served markets. In order to make these opportunities viable, enterprises need to focus on the following critical success factors:

**Consumer awareness:** Given the low awareness of solar off-grid lighting products and their benefits, investors and enterprises need to generate demand by educating potential consumers about solar off-grid lighting products. Substantial resources may be required to reach them, some of which are in remote regions.

**Consumer finance:** Since most off-grid households are low-income, they tend to lack access to financing options. There is a large market for providing credit to such households to invest in solar off-grid lighting products. However, banks and microfinance institutions (MFIs) are typically unwilling to offer the loans owing to a lack of awareness of the market potential, after-sales challenges and other issues which can be systematically addressed.

**Credit access for SMEs:** Lack of readily accessible debt and equity capital is a major constraint for SMEs in the solar off-grid lighting market. There is an opportunity for investors and financiers who can offer financing tailored for emerging SMEs.

**Product quality:** With the market dominated by cheap and sub-standard solar lighting products, there is a need for appropriate solutions to prevent market spoiling and to differentiate good quality products. Consumer mistrust in solar or LED technology can be addressed by providing reliable information about better quality products.

**Distribution network building:** Because most off-grid households are often in remote areas, there is a need to create efficient distribution and after-sales networks.

**Policy advocacy:** In some countries, there is scope to create awareness amongst policymakers and governments regarding market-distorting policies such as subsidies on kerosene (in India) or free distribution of SHS (in Indonesia). Highlighting the cost-competitive, health and environmental benefits of solar off-grid lighting products in the long term could potentially promote the growth of commercial and sustainable models and open up the market.



A school with an installed SHS in India

*Image courtesy of SELCO*

## Country Assessment

Based on the market-scoping exercise, the focus countries were compared across the following parameters, which are critical factors to attract private sector participation:

**Market potential:** This factor aims to capture the potential of the market as defined by the total number of off-grid households and their current spending on kerosene for lighting and other lighting products. This is one of the key determinants of private sector participation.

**Availability and quality of critical enabling infrastructure for commercial models:** This factor aims to capture the presence of key enabling infrastructure for private sector enterprises to scale the market in the countries. This covers distribution and retail networks to reach out to rural consumers, access to finance for consumers and businesses and the presence of local stakeholders such as community-based organizations (CBOs) and MFIs, who can undertake grass-root level marketing and promotion activities.

**Maturity of solar off-grid lighting industry:** This factor helps private sector enterprises understand the extent of the industry in the country. The relative maturity of the private solar off-grid lighting industry is measured by the presence of local manufacturing capacity of products and/or components, product quality testing capacity, prevalence of industry standards and the presence of commercial models.

**Overall policy environment and government support:** This factor aims to capture the attractiveness of the policy and regulatory support available to the solar off-grid lighting industry by examining the presence of favorable import duties, taxation policies, and subsidiary frameworks.

**Presence and quality of existing energy access initiatives for promoting private sector models:** Government/donor supported lighting access programs with a market-based approach that are focused on facilitating the growth of commercial private sector models (versus fully subsidized programs that may be hampering a burgeoning private sector play) are a key enabler for private sector enterprises. This factor aims to capture the presence of such initiatives in the countries.

The following table provides a summary of the country assessments based on these parameters:

Country	Market Potential (off-grid households' total spend on major conventional sources of lighting)	Availability and quality of local infrastructure	Maturity of private solar off-grid lighting industry	Overall policy environment and government support (energy access policies, subsidies on conventional fuels etc.)	Presence and quality of any existing energy access program(s) for promotion of commercial models <sup>[i]</sup>
India	75 million households; USD 2.2 billion (Kerosene spend)	Deep rural reach established by FMCG companies and the market	The industry has only become active in the last 3-4 years with tremendous potential for the future	Low/no import duties and favourable taxation policies negated by huge subsidy on kerosene	Upcoming government subsidy program, JNNSM no track record but huge expectations
Bangladesh	17 million households; USD 0.36 billion (Kerosene spend)	Strong presence of MFIs for distribution and marketing	On high growth trajectory following the start of the IDCOL program; poised to grow more in the coming years	Insignificant subsidy on kerosene; Low/no import duties; Favourable taxation policies	IDCOL program - successful in market building and growth
Nepal	3 million households; USD 0.19 billion (Kerosene spend)	Transportation and distribution to the remote rural and hilly areas is a challenge	Relatively slow market growth, but the potential is still there	No subsidy on kerosene; Low/no import duties	AEPC program - market dependent on solar subsidies and several donor programs in planning stages
Cambodia	2.2 million households; USD 0.11 billion (Kerosene and Battery spend)	Strong presence of battery charging stations in remote areas which could be a potential distribution partner. MFIs mostly located in urban areas	Sector is nascent and only a limited number of players in the market. However, innovative players (Kamworks) are experimenting with business and distribution models	No subsidy on kerosene; Import duties and taxes levied	World Bank supported REF revised program to be implemented

[i] For abbreviations please refer to the Abbreviations definition at the beginning of this report. For each program description, please refer to the individual country sections.

Country	Market Potential (off-grid households' total spend on major conventional sources of lighting)	Availability and quality of local infrastructure	Maturity of private solar off-grid lighting industry	Overall policy environment and government support (energy access policies, subsidies on conventional fuels etc.)	Presence and quality of any existing energy access program(s) for promotion of commercial models <sup>[i]</sup>
Indonesia	20 million households; USD 1.34 billion (Kerosene spend)	Large archipelago which is difficult to access. MFIs solely operate in urban and semi-urban areas on the main islands	No private sector initiatives to target the BOP on a commercial basis, everything through a government tender process. No financing support for companies who would like to target them directly.	Subsidized kerosene;	Free distribution of SHS under the government tender scheme
Pakistan	11 million households; USD 0.11 billion (Kerosene spend)	Strong presence of MFIs and developmental aid organizations; rural networks not well established	Very nascent market	Political instability; High import duties	No program currently
Philippines	2.5 million households; USD 0.18 billion (Kerosene spend)	Transportation and distribution to remote areas is a challenge, MFIs located mostly in urban areas. Law and order in some remote areas remain an issue, for the lack of reliable distribution channels	Well developed solar industry with a large number of players. Government funded programs targeting the BOP, have helped the market to develop	Taxation	World Banks RPP and, USAID's AMORE subsidy driven and had little impact

The table above shows that India offers the largest opportunity in terms of market potential and is also relatively ahead of the other countries in terms of maturity of private sector-led models. Indonesia and Pakistan,

home to approximately 150 million off-grid households or approximately 20% of Asian off-grid households, present the most barriers for private enterprises to enter these markets.

## Recommendations

Following are some key observations for private sector companies and investors interested in the solar off-grid lighting space. These points are based on the report findings on enterprise, government and donor driven activity in solar off-grid lighting markets across the seven countries.

- **Solar lanterns and SHS can help to reduce the number of un- and under-electrified rural households**

Each country profiled in this report is home to a significant number of off-grid households. The slow rate of electrification and the lack of technical and/or economic feasibility make extending the grid to these households a distant reality. Grid extensions aside, the challenges of generating adequate power to meet the current demand leave many grid-connected households under-electrified. Given these realities, both solar lanterns and SHS offer an immense potential to provide clean lighting to low-income households. Some governments have already built in the provision of these products into their electrification plans. For instance, the Government of Bangladesh considers a household with a SHS installed as electrified, which is not the case in India.

- **Any program or pilot project design must include an effective mechanism to ensure product quality and offer after-sales support**

Many programs / pilots have failed despite huge investments due to the lack of quality assurance and monitoring and/or the lack of adequate planning to set-up an efficient after-sales network. The success of consumer financing efforts depends heavily on product performance. Channeling poor quality products or failing to service a faulty product during the financing term is a significant credit risk borne by the financial institutions.

Instances of such unsuccessful programs can be seen in the Philippines, Indonesia, Pakistan, etc. However, in Bangladesh, the Infrastructure Development Company's (IDCOL) solar program, which has effectively managed its after-sales network through its partner organizations, has been relatively successful in scaling up.

- **Grass-roots organizations are critical for promoting the use of solar off-grid lighting**

The lack of consumer awareness on solar lighting products and their benefits is a key barrier facing the sector. The barrier is further heightened by the push<sup>[6]</sup> nature of the products and the limited resources available to SMES in this market enterprises to promote solar off-grid lighting. Last mile delivery to rural consumers is another significant challenge. In this context, local CBOs can play a vital role in increasing the use of these products. As we have seen in Bangladesh, a critical factor driving the IDCOL solar program's success has been the presence and local outreach of its partner organizations, which are primarily CBOs. The partner organizations have built high levels of consumer trust and easy access to rural households over many years. These factors have allowed the program to overcome some of the above-mentioned challenges. Similarly, in India, larger enterprises, such as Tata BP Solar and Schneider etc., are looking to or have partnered with local CBOs to support their solar off-grid lighting business plans.

- **The sector at its current stage requires patient<sup>[7]</sup> / subsidized capital to scale**

The market for solar off-grid lighting products is nascent, and a pure commercial approach to serve the off-grid market will take some time to evolve.

[6] Push products are those where the consumer demand is low and companies need to aggressively market and sell their products to create demand

[7] An investor with patient capital is willing to make financial investment into a business (social enterprise) which has relatively longer gestation period of generating profits

The market today is characterized by long payback periods, given the challenges set out above and the end-consumer profile.

SMEs dominate the sector today. While large enterprises with deep pockets have the potential to sustain themselves and scale up, the market is yet to witness significant activity from these companies. SME enterprises operating in the market are severely constrained by a lack of resources to scale up.

There is a mismatch between the current supply of financing (debt and equity) and the demand for financing in terms of risk profile, return expectations, collateral requirements, etc. The current need is capital (debt and equity) that is characterized by long time horizons and a high risk tolerance. Enterprises that have successfully started to scale up operations in this market have been supported with patient / subsidized capital.

The following observations on current policies point out the need for both direct policy and advocacy by the donor organizations and multilaterals to catalyze the solar off-grid lighting market growth.

- **Policy and subsidies that strengthen the whole value chain are more effective than a direct subsidy intervention that simply reduces the end-consumer price**

Nearly all the markets studied have a government subsidy program to support solar off-grid lighting. However, every program adopted a different approach, with varying levels of success.

The Bangladesh program has, so far, focused on strengthening the capacity of the entire value chain - from provision of soft loans to facilitate consumer financing, to providing marketing and promotion support, to quality control support. The program's current scale depends less on the equipment price subsidy, allowing it to progressively scale back its price support. The program has been able to catalyze market demand for solar off-grid lighting products and aims to scale up aggressively in the coming years.

On the other hand, Indonesia's program, based on free distribution of Solar home systems, is stifling the entry of the private sector enterprises through its rigid tender-based approach and is resulting in significant user dropouts.

As these examples of programs suggest, it is extremely critical that any intervention be designed and implemented to create an eco-system for solar off-grid lighting that can gradually become self-sufficient and wholly sustainable.

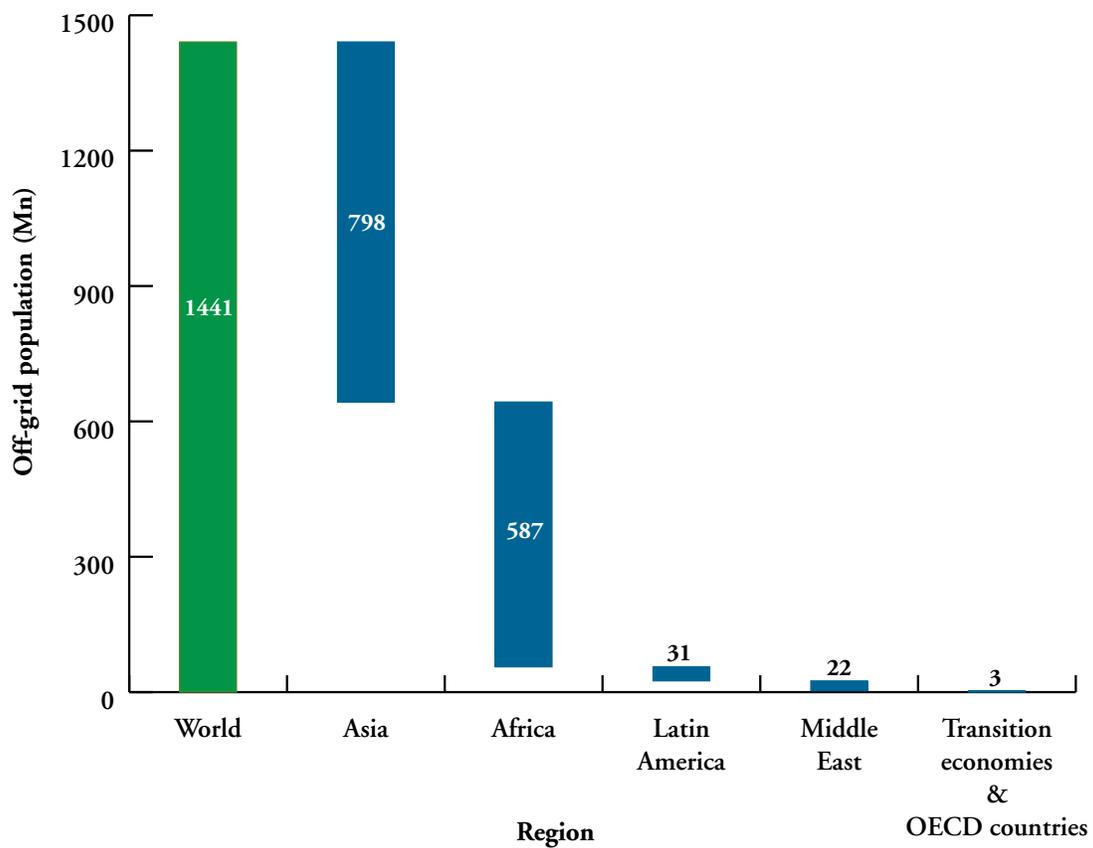
- **Kerosene subsidy is a major challenge to the development of solar off-grid lighting market**

Indian and Indonesian governments provide significant subsidies on conventional fuel sources such as kerosene for domestic usage (lighting and cooking). Heavy subsidies on kerosene make it difficult for the solar off-grid lighting market to scale up, as the conversion costs for the consumers increase manifold. In such a scenario, it makes it more challenging to convince consumers to change to the cleaner, more efficient solar off-grid lighting products.

## 1. Asia Overview

Asia has the largest off-grid population in the world, with 55% of the global off-grid population. This translates into 22% of the population in Asia and 798 million people

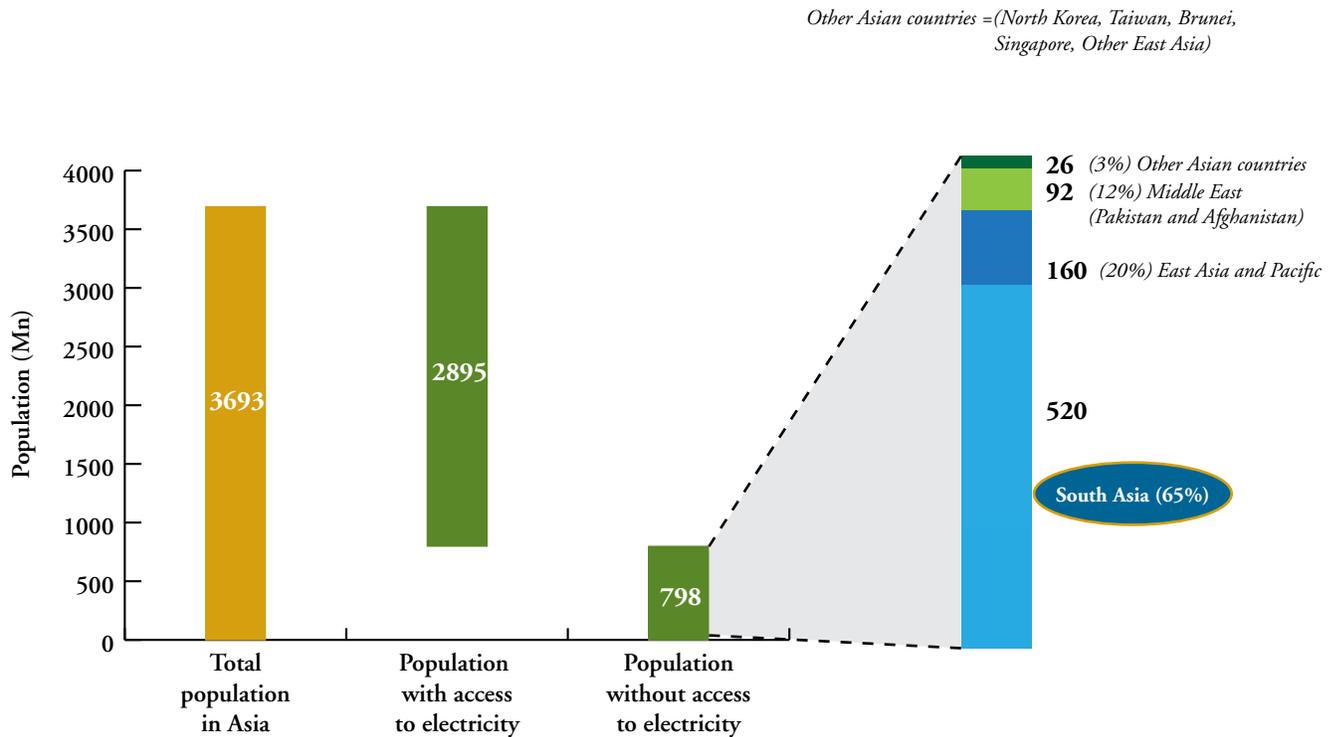
without access to electricity. Of this, over 700 million or 90% are located in rural Asia.



Source: International Energy Agency, Intelcap analysis

Figure 1.1: Access to electricity by region (2009)

**South Asia accounts for 65% of the off-grid population<sup>[8]</sup>**



**Note:** South Asia comprises of Bangladesh, India, Nepal and Sri Lanka; East Asia and Pacific comprises of Cambodia, East Timor, Indonesia, Laos, Malaysia, Philippines, Thailand, Vietnam, China, Burma and Mongolia; The Middle East comprises Pakistan and Afghanistan; Other Asian Countries comprises of North Korea, Taiwan, Brunei, Singapore and Other East Asia

Source: International Energy Agency, UN Habitat, Intelicap analysis

**Figure 1.2: Off-grid population in regions across Asia (2009)**

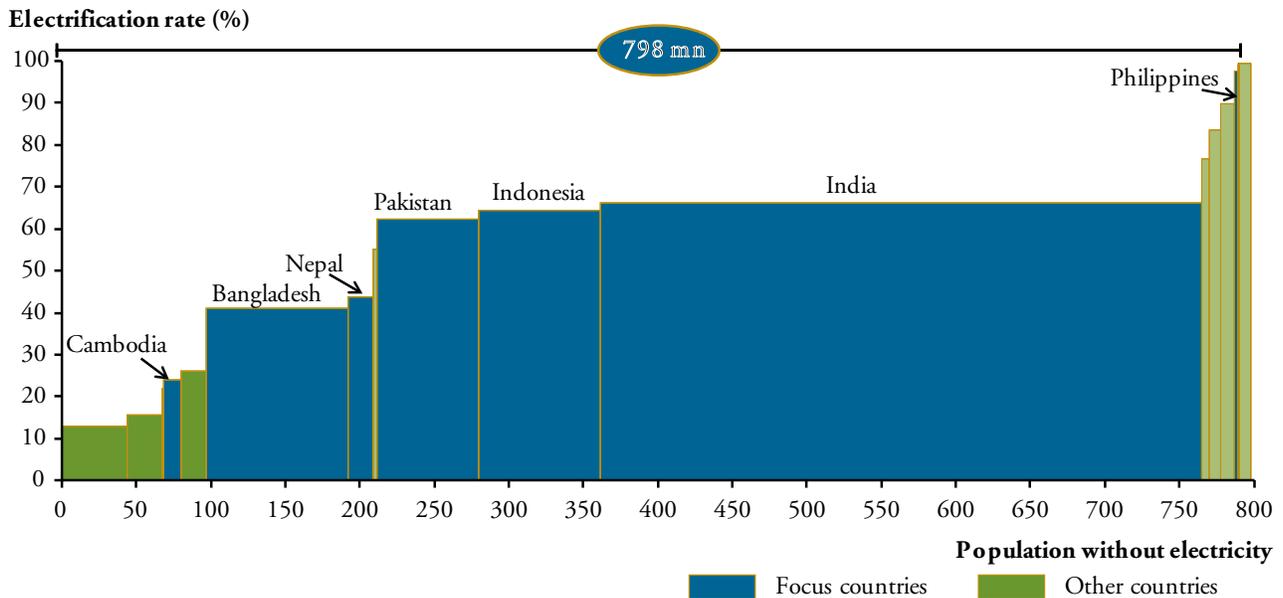
[8] 2009 data has been used for overall electricity access for countries in this report, but as the rural and urban electrification rates were not available for 2009 at the time of writing this report, 2008 data was used as a proxy

**The seven focus countries constitute the majority of the Asian off-grid population**

These countries together represent 86% of the overall off-grid population in Asia. India alone contributes to approximately 50% of the off-grid population with approx. 400 million people<sup>[9]</sup> without access to electricity.

**Kerosene is the dominant off-grid lighting option in these countries**

Our estimates are that the total expenditure on kerosene for lighting in these countries is approximately USD 3.68 billion per annum. The bulk of this is contributed by India, where the kerosene expenditure for lighting is estimated to be approximately USD 2.2 billion per annum.



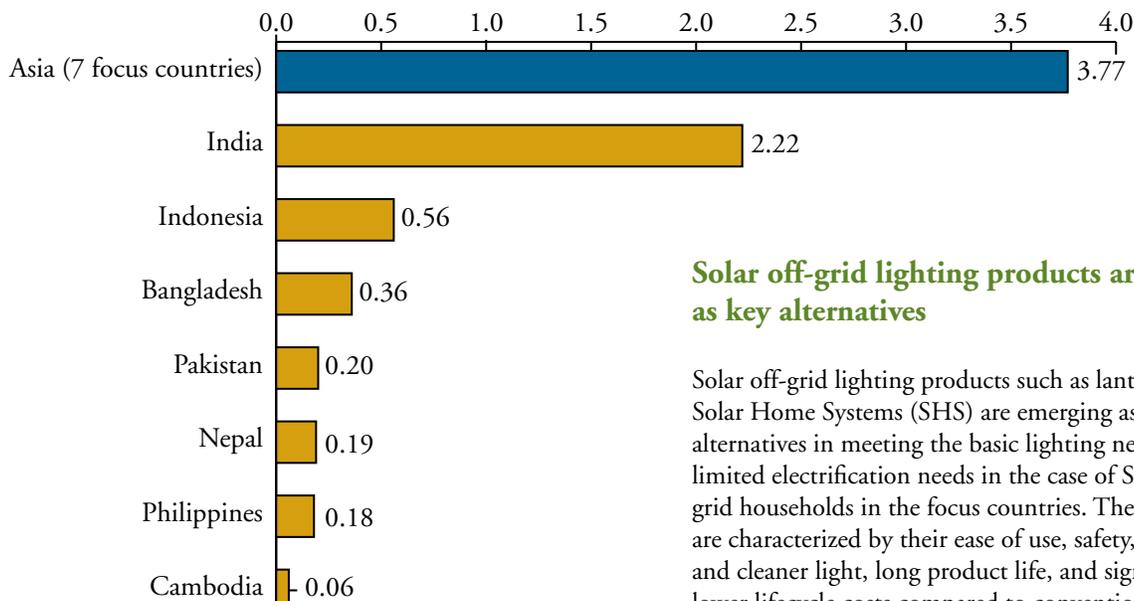
Source: IEA, Intelicap analysis

**Figure 1.3: Population without access to electricity by country (2009)**

[9] The 2011 Census Report indicates a 67% electrification rate and a population of 1.2 billion people which implies an off-grid rate of 33% and approximately 400 million people off grid

According to the IFC and WB Group 'Lighting Africa' report, the annual expenditure on conventional fuels for lighting in Africa is estimated to be USD 10.5 billion. Despite the off-grid population in the 7 focus countries being higher than the whole African continent, the expenditure in Asia is relatively lower. 70% of the off-grid population of these countries is in India and Indonesia, where governments provide huge subsidies on kerosene.

**Annual Kerosene expenditure (Bn)**



**Solar off-grid lighting products are emerging as key alternatives**

Solar off-grid lighting products such as lanterns and Solar Home Systems (SHS) are emerging as key alternatives in meeting the basic lighting needs (and limited electrification needs in the case of SHS), of off-grid households in the focus countries. These products are characterized by their ease of use, safety, brighter and cleaner light, long product life, and significantly lower lifecycle costs compared to conventional sources of lighting – mainly kerosene.

A wide variety of solar off-grid lighting products currently exist in their markets, including solar torches and flashlights, desk and working lamps, solar lanterns, solar multifunctional devices, solar home systems.

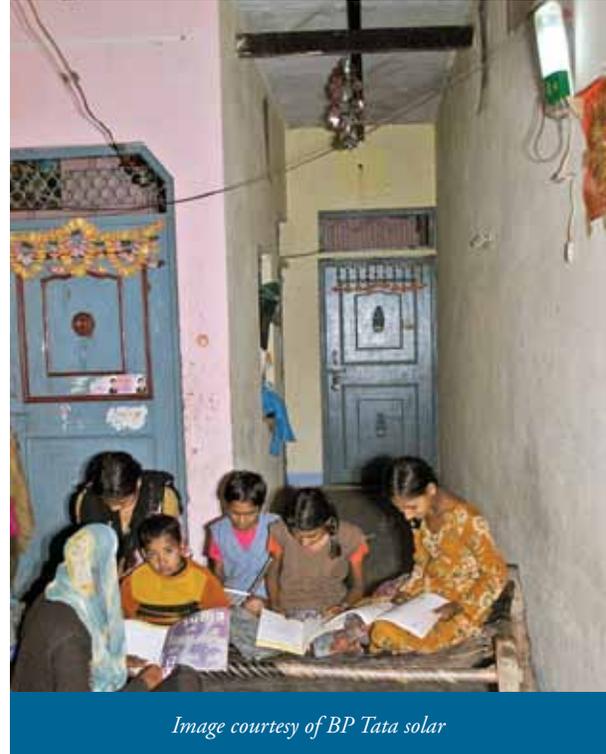
Source: UN data, Primary research, Intelicap analysis

**Figure 1.4: Annual kerosene expenditure by country**

In the focus countries, single light point systems such as solar torches, flashlights, lanterns and multifunctional devices, are typically referred to by the catch-all term ‘solar lanterns’, disregarding the marginal technical nuances between them. SHS are considered separately as they are more expensive and have a larger feature set and applications.

### Solar lanterns and SHS target different market segments

The market segments targeted by solar lanterns and SHS are quite different. The market potential for a SHS is much higher amongst higher-income customers whereas the primary market for solar lanterns is the lower-income customer segment that needs lighting at affordable prices. This is represented below.



Off-grid solar lighting market segmentation in Asia

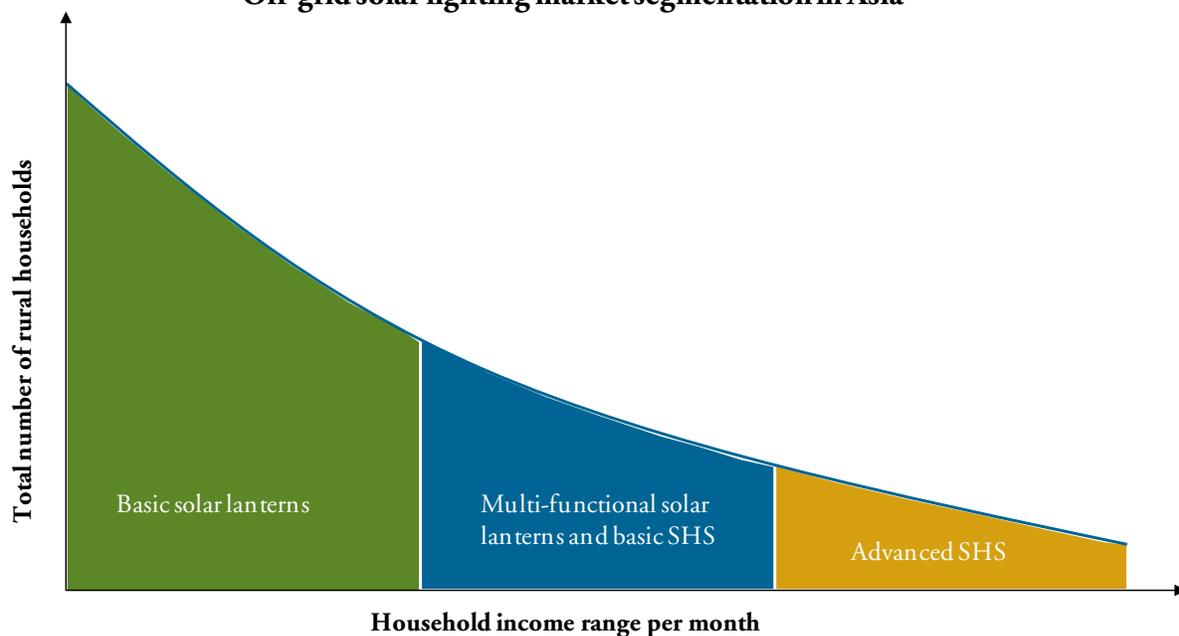


Figure 1.5: Market segmentation of solar off-grid lighting market

There are five key product categories in the off-grid lighting space that are highlighted in the table below. Products can be categorized based on a combination of the functionality, portability, and overall service level.

**Basic solar lanterns:**

In addition to usage amongst the lower-income households, solar lanterns are used extensively for portable applications by certain professions such as fishermen, silk farmers, and night security guards. Their demand is also driven by the need to work early in the morning and/or late in the evening, coupled with the benefits of brighter and safer light that solar lanterns provide.

These lanterns can perform only one or two basic functions such as acting as a task light and/or as a solar torch/flashlight.

**Multi-functional solar lanterns:**

This product’s distinguishing characteristic is that it comes with more functionality than the basic solar lantern. These features include outlets for mobile phone charging, radio charging and charging through dual modes – solar and AC points. Some lanterns in the market even come with built-in radios. While all income levels find these products more useful than basic solar lanterns, many cannot afford them.

Basic lanterns					
Torch Light	Task Light	Ambient Light	Multifunctional lantern	Basic SHS	Advanced SHS
					
<b>Portable</b>	<b>Portable</b>	<b>Portable</b>	<b>Portable</b>	<b>Permanent</b>	<b>Permanent</b>

*Images courtesy of Schatz Energy Research Center (R. Hosbach)*



**Photo of a traditional Kerosene lantern**

**Basic SHS:**

These are quite similar in functionality and in target customer segment to the multi-functional solar lanterns. Their key distinguishing feature is that their lights are separate from the charging/battery unit. This allows the lighting to be provided in different rooms as per the customer’s need unlike lanterns that can only supply lighting at one location at a time.

**Multifunctional SHS:** Typically larger lighting systems (10 – 40 Wp) that offer lighting for multiple points with additional functions such as mobile phone charging and power for running loads such as radios, black & white television, etc.

**Advanced SHS:**

As the income level increases further, the ability to pay for lighting and other electricity needs increase as well. Amongst the customers that are the key target segment for advanced SHS, the typical applications are for lighting up houses with multiple rooms that would need more than

one light and for using fans, TVs, radios and other small electrical appliances as needed. Very large systems (>40 Wp) that offer power to run loads such as multiple fans, color television, large number of lights etc., over and above the functionalities provided by Multifunctional SHS.

**Technology drives the off-grid lighting market****Light Sources**

The solar products in the market today typically have either CFL or LED lamps



LED's (Light Emitting Diodes): LED's are characterized by their low power requirements



CFL's (Compact Fluorescent Lamps): CFL's use much less power compared to traditional incandescent lamps but considerably more power when compared to LED

**Batteries**

Batteries can be of the following 3 types:



Lead-acid batteries: These are the oldest type of rechargeable batteries and are typically used in SHS



Lithium-ion batteries: These batteries have seen more application in portable products as they have one of the best energy densities



NiMH batteries: Nickel-Metal Hydride cells have a high energy density but a high self-discharge rate, which leads to lower battery life

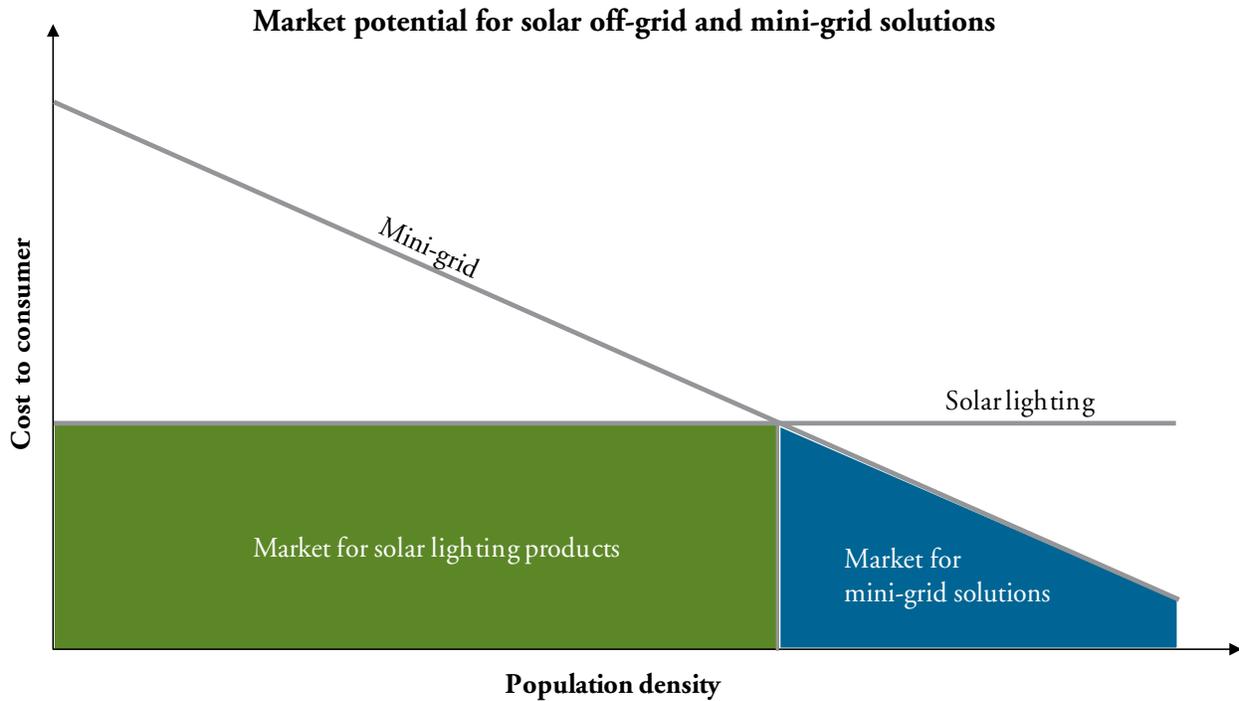


Figure 1.6: Market segmentation by population density

### Applicability of solar off-grid lighting products is population-density dependent

Multiple solutions such as solar lanterns, SHS and mini-grids<sup>[10]</sup> have emerged to cater to the lighting needs of off-grid households. The applicability of these solutions depends on the population-density of an area.

The diagram above illustrates how when the population density is low enough, solar off-grid lighting products are the more economical option for the consumer.

Once a high enough population density is reached and if mini-grid solutions are available to customers, they may be a more economical option than standalone lighting products. The key consumer benefit of this option is that the costs may decrease with corresponding increases in the population density of consumers in that area.

[10] A minigrid is a small local electricity utility producing power using a small generator. The power is distributed over wires to households and businesses in localities neighboring the generator



Husk Power Systems Biomass minigrid in Bihar, India

*Photo: A. Jacobson*

### Market penetration of solar off-grid lighting products is still insignificant

The market penetration of solar off-grid lighting products is insignificant when compared to the vast number of off-grid households. The following table shows the

estimated sales of good quality solar lanterns and SHS in our focus countries.

Countries	Solar Lantern Sales <sup>[i]</sup>	Solar Home Systems Sales <sup>[i]</sup>
India	2.3 - 3.2 million	1.0 – 1.2 million
Indonesia	NA	260,000
Bangladesh	NA	680,000
Nepal	NA	229,000
Philippines	approx. 3,000	40,000
Pakistan	NA	NA
Cambodia	10,000	10,000 – 20,000
<b>Total</b>	<b>2.3 - 3.2 million</b>	<b>2.2 – 2.4 million</b>

[i] Table includes both subsidized products sold as well as unsubsidized products

## Significant presence of sub-standard solar lanterns

The issue of sub-standard solar off-grid lighting products entering the markets is primarily restricted to the solar lantern market. High levels of variation are currently observed in the price-performance ratios of lanterns available in the market today. The performance of electronic circuits in these lanterns also varies widely with respect to charging, efficiency and type of circuit protection.

There is currently no globally harmonized framework for testing and certifying products although efforts, e.g. by the International Electrotechnical Committee, are underway. Such requirements and certifications would ensure that only good quality products enter the market and that poor quality lanterns do not lead to consumer mistrust in good quality solar lanterns too.

### Lighting Global's Quality Assurance Framework

Lighting Global has developed a global quality assurance framework for off-grid lighting. The framework includes a test protocol, sampling requirements, Minimum Quality Standards, Recommended Performance Targets, and Standardized Specifications Sheets.

Any organization can adopt their own set of Standards and Targets, working within the Lighting Global QA framework to suit their needs.

The Lighting Global QA framework originated with Lighting Africa, but since then has been applied for global projects, including the UNFCCC CDM methodology for carbon credits.

*See [www.Lighting Africa.org](http://www.Lighting Africa.org) for more details*

## Solar off-grid lighting companies have adopted four key distribution models

Distribution is a critical success factor for solar off-grid lighting companies. Most companies operating in the

focus countries are still experimenting with multiple distribution models. Based on this study, four major distribution models used by private sector initiatives across the seven countries have been identified:

Model description	Channel evaluation
<p><b>Institutional partnerships:</b> Manufacturers tie up with institutions (either for-profit or non-profit) that have significant presence in rural areas</p>	<p><b>Advantages</b></p> <ul style="list-style-type: none"> <li>• Access to wide and deep distribution channels</li> <li>• Opportunity to leverage on the partner's ready client base</li> </ul> <p><b>Challenges</b></p> <ul style="list-style-type: none"> <li>• Ambiguity on cost sharing and risk sharing</li> <li>• Concept selling would be a challenge. For example, in India, Tata BP Solar could not leverage on the Tata Chemicals' channel because solar off-grid lighting products, unlike fertilizers, do not have a ready pull and need to be pushed aggressively</li> <li>• May not work for SHS as it is not an off-the-shelf product. Most organizations consider SHS to be a customized technical solution</li> </ul>
<p><b>Company owned branches:</b> Branches set up in the target geographies for distribution</p>	<p><b>Advantages</b></p> <ul style="list-style-type: none"> <li>• Stronger control on margins, brand, and supply chain</li> <li>• Can drive and ensure concept selling of SHS effectively by working closely with sales staff</li> </ul> <p><b>Challenges</b></p> <ul style="list-style-type: none"> <li>• High initial investment required to set up branches and therefore potentially more relevant for SHS</li> <li>• Management and coordination of staff across branches is challenging</li> </ul>
<p><b>Micro-franchising:</b> Manufacturers identify micro-entrepreneurs at a village level, work closely with them on distribution, marketing and servicing</p>	<p><b>Advantages</b></p> <ul style="list-style-type: none"> <li>• Works well at a local level for a company to begin operations</li> </ul> <p><b>Challenges</b></p> <ul style="list-style-type: none"> <li>• Sales are entirely dependent on the micro-entrepreneur</li> <li>• Likelihood of up-front payment to the suppliers by the micro-franchisee is low</li> <li>• Identification of a micro-entrepreneur in every village and regular coordination can be a time-consuming and cumbersome process</li> </ul>
<p><b>Traditional distribution channel:</b> Manufacturers sell their products to the distributors, who in turn sell them to dealers. The dealer generally has a network of sub-dealers or micro-entrepreneurs depending on the remoteness of the areas. The distributors are usually of 3 types – consumer durables, electrical goods and exclusive solar</p>	<p><b>Advantages</b></p> <ul style="list-style-type: none"> <li>• Common and well-understood model</li> <li>• Potential for higher market penetration</li> </ul> <p><b>Challenges</b></p> <ul style="list-style-type: none"> <li>• Inadequate and underdeveloped number of distributors with a nationwide reach</li> <li>• Ensuring after-sales service through various distributors and dealers</li> <li>• Reputation risk to the brand</li> <li>• Concept selling is a challenge</li> </ul>

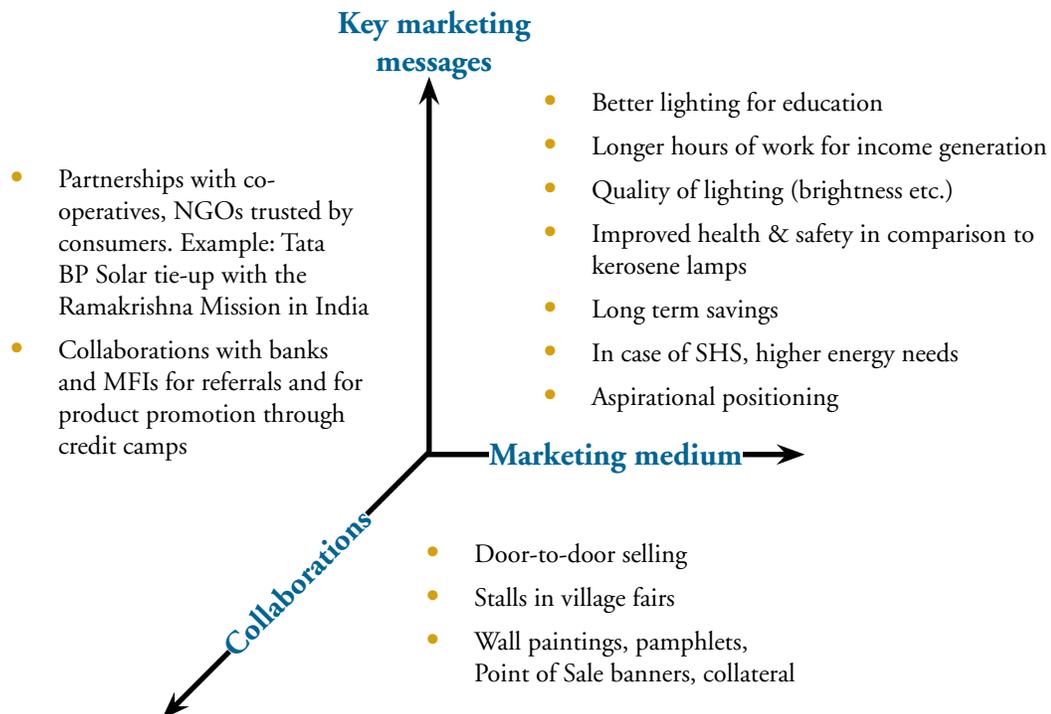
## Solar off-grid lighting companies are adopting various marketing and promotion practices to drive uptake

Given the low levels of awareness and some misconceptions about solar off-grid lighting due to unsatisfactory experiences from sub-standard products, it is imperative for businesses in this market to invest resources into education, marketing and promotion. Social marketing<sup>[11]</sup> is especially critical in driving uptake. Companies are testing various approaches

[11] Please refer to the Appendix for successful social marketing examples in India

to communicate a host of marketing messages to the customers using different media and collaborations as represented below.

In spite of the various company-level promotional efforts, the collective impact is still insignificant across the countries with the rural off-grid population needing further education on solar off-grid lighting products and their benefits.



### Access to finance for low-income consumers remains a key challenge

While a select few off-grid households are able to purchase solar off-grid lighting products easily on a cash basis, many low-income customers find it difficult to pay the upfront costs associated with these products. A survey conducted by Intellecap in 2009 of rural low-income Indian households that owned solar lanterns (costing USD 15-20) revealed that the provision of access to finance had positively influenced their purchase decision.

The following figure depicts the typical price range of these products in Asia. The pricing range for lanterns is very broad (e.g. 20-70 USD for basic lanterns) whereas for SHSs, pricing is in a tighter range (with the exception of Philippines).

The market for providing finance for customers of solar off-grid lighting products remains unaddressed in most

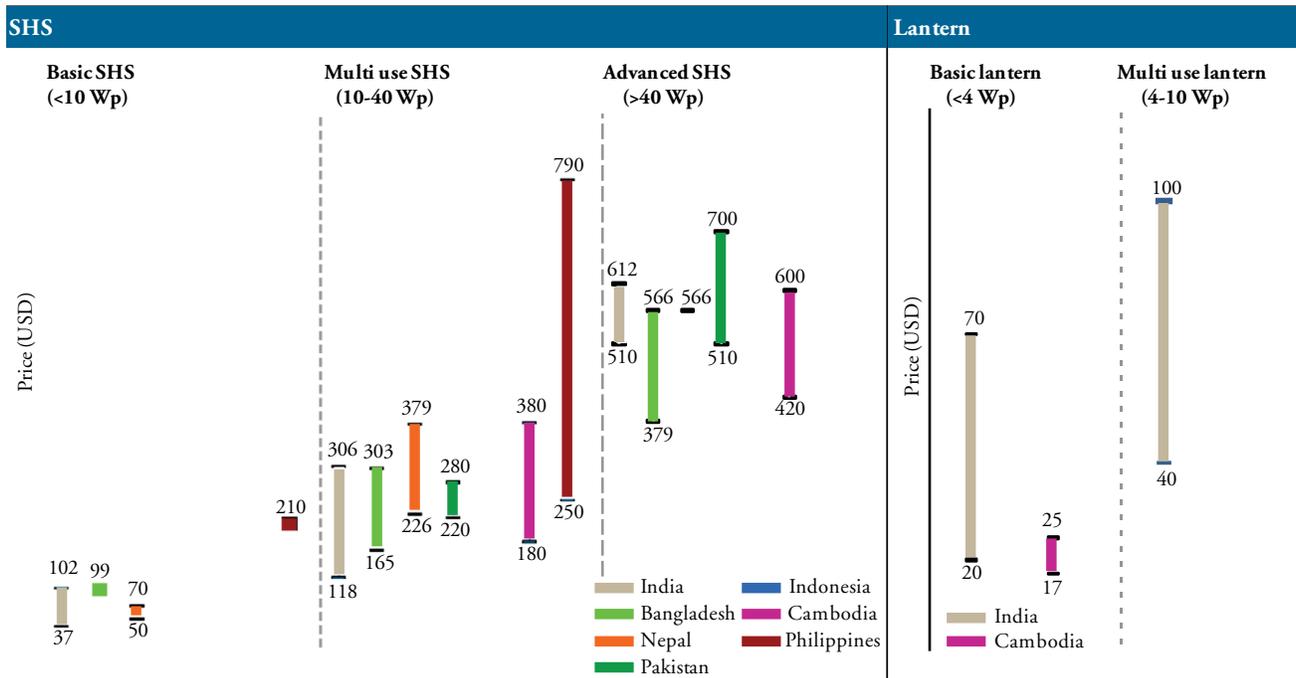
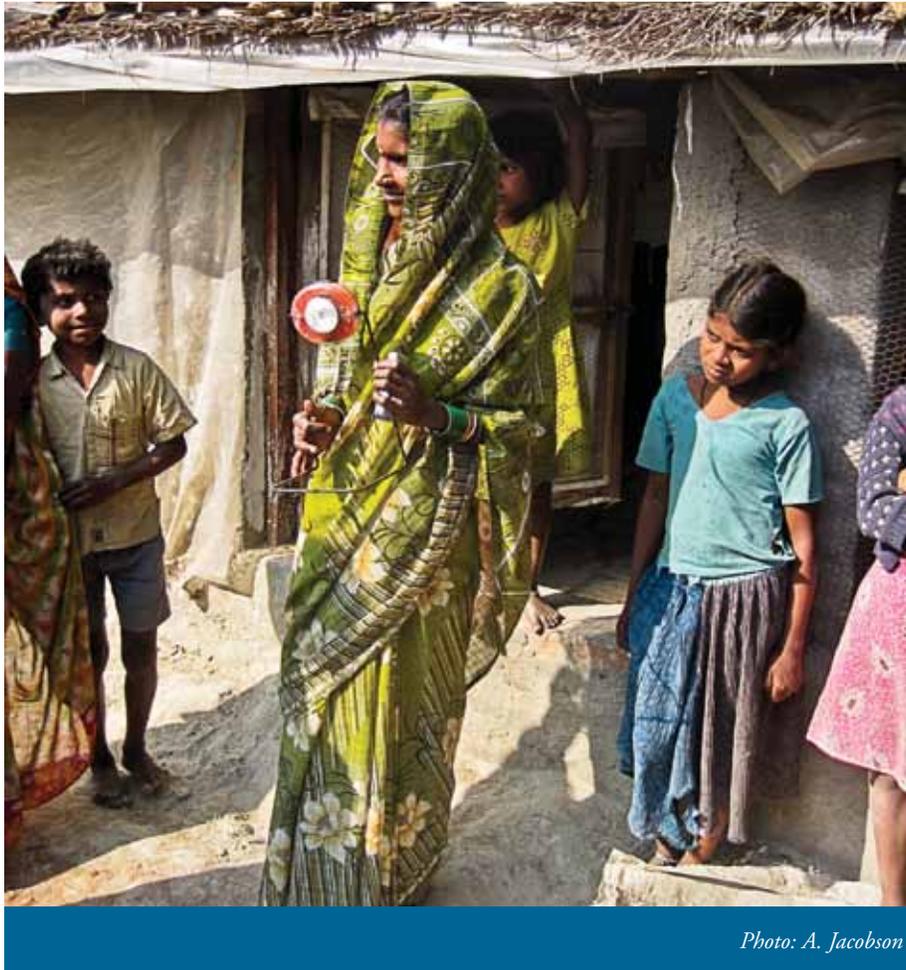


Figure 1.7: Typical prices of solar off-grid lighting products in Asia



*Photo: A. Jacobson*

of the focus countries. Commercial banks as well as microfinance institutions shy away from extending credit, citing high transactional and operational costs in the face of low demand for solar lighting products and remote location of most target customers. Additionally, given the low-income status of such consumers, they also see a high default risk, part of it stemming from their distrust of the product quality – if it dies before the loan terms, chances of recovery decrease. Product quality is a key factor for ensuring the viability of the off-grid lighting market across multiple dimensions.

All the above mentioned issues are more acute in solar lanterns because of their small loan ticket size, low repossession or collateral value and relatively lower warranty period (usually no more than a year). Moreover, providing after-sales service is a bigger challenge in the case of lanterns compared to SHS as lanterns are low-value products and need scale for it to be viable for the companies selling them.

In light of these difficulties in working with individual customers and products, some banks and MFIs are interested in supporting models of off-grid lighting that aggregate customers. This could be through providing micro-entrepreneurs with financial support to start their own solar lantern charging stations or providing small dealers with credit to buy products from companies for distribution to customers on direct sale or flexible repayment terms.

An example of this financing support can be seen in the pilot being run by Yes Bank, an Indian bank, to provide microfinance loans to “Lighting a Billion Lives (LaBL)” entrepreneurs with the disbursement and on-ground monitoring to be handled by a partner MFI.

## Innovative models are emerging across the globe to overcome barriers in accessing finance

### Model 1: Fee-for-service / rental model for solar lanterns

In this model, a micro-entrepreneur who has a bank of batteries, panels and lanterns rents the charged batteries/lanterns to the users. The user pays a fee for charging services (in case of batteries) or a rental fee (in case of lanterns). The micro-entrepreneur could either buy the inventory upfront or pay the supplier on installments.

SELCO, Barefoot and Schneider are some of the companies that are piloting such models in India. Recently, the LaBL program implemented by TERI has also adopted this model (see images). The advantages of the model are:

- Flexibility to rent or recharge the lantern only when required
- Maintenance and servicing issues are not faced by the customer



Image Courtesy of Simpa Networks



Picture Courtesy: Lighting a Billion Lives - A TERI initiative

**Model 2: ‘Pay-as-you-go’- loan repayment over mobile:**

Advantages of the model are that:

A technology company called Simpa is piloting a ‘pay-as-you-go’ model in collaboration with SELCO in the state of Karnataka in India. In this model, consumers pay for energy credits through the “easy recharge” agents, which mimics the mobile airtime recharge process. Simpa then collects from the agents (in kilo watt per hour - kWh).

Each payment accumulates towards the final purchase price and once fully paid, the system unlocks permanently and delivers free solar energy from that point onwards. Simpa collects the payments from the mobile airtime distributors and pays the SHS supplier after deducting a service charge.

- Increasing mobile penetration in rural areas has led to a vast mobile airtime distributor network—the model aims to leverage this network for its operations
- Customer can make payments at his/her convenience based on his/her usage requirements- this advantage puts the model on par with kerosene
- Lender can better manage bad debt/non-payments, through increased leverage through the ability to turn off the solar system remotely

**Model 3: Acquisition of solar off-grid lighting products through remittances:**

A few companies are still developing this model. The idea is to provide SHS loans to people working in semi-urban / urban areas whose families may be living in off-grid villages. Banks are to make an upfront payment to the supplier and collect loan repayments from the working people. It would be the responsibility of the suppliers to deliver the product to the respective households in the villages.

An example of an existing program that attempts this is the FOMIN<sup>[12]</sup> project in Honduras and Haiti, which aims to finance solar off-grid lighting products through remittances.

**Model 4: Financing SHS through monthly payroll deductions:**

Under this program, companies would partner with large agri-businesses, who would deliver solar lighting products to farmers and deduct repayments on behalf of banks from the crop payments made to the farmers. A payroll deduction program to finance the sale of SHS for palm-oil farmers has been proposed by UNEP<sup>[13]</sup> in Indonesia. This scheme is targeted at these farmers as they often have a stable and regular income.

**Model 5: Increase affordability through modular design:**

Companies such as Sundaya in Indonesia are focusing on the modular construction of their solar off-grid lighting products. This enables the low-income segment consumer to purchase the basic system with one light initially and then add more lights and other accessories as and when their purchasing power increases. While this is not a microfinance strategy per se, it can achieve some of the same goals - spreading out the cost of a lighting system over time.

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[12] Multilateral Investment Fund (member of IDB group)

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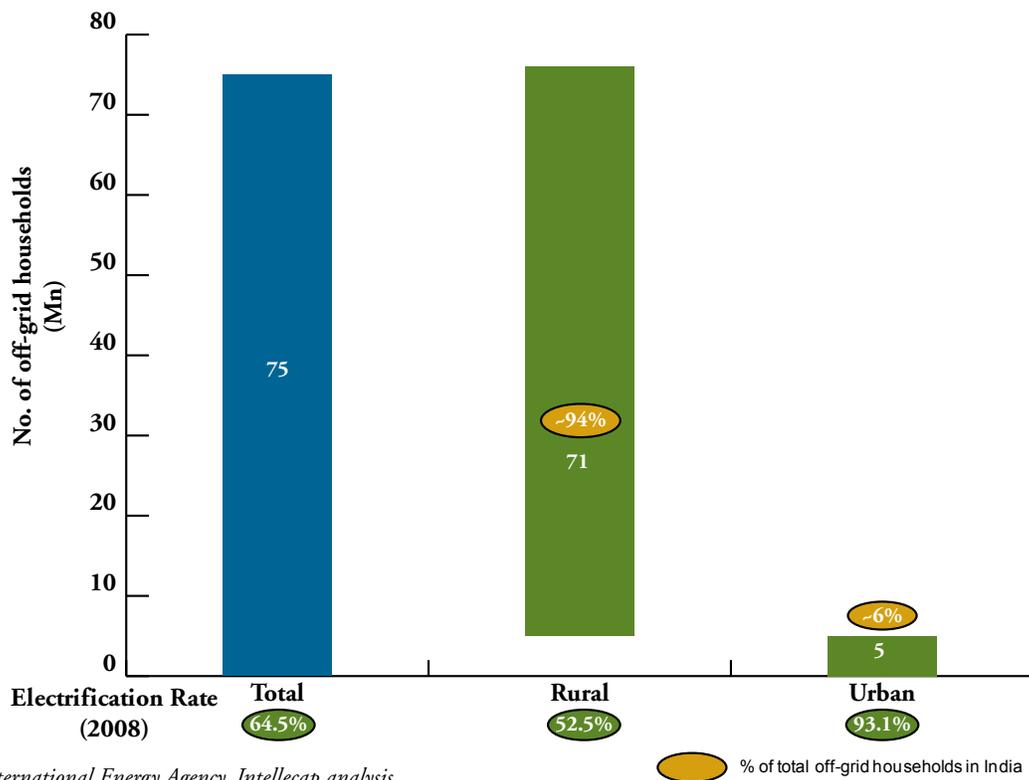
[13] Financing Mechanisms and Public/Private Risk Sharing Instruments for Financing Small Scale Renewable Energy Equipment and Projects, UNEP

## 2. India Market Scoping

### 2.1 The current state of off-grid lighting

India faces the most acute challenge of electricity access in the world with 75 million of its 226 million households off the grid, the largest such demographic globally<sup>[14]</sup>. In addition, it has a very high population that faces under-electrification (assuming that households consuming less than 50 kWh<sup>[15]</sup> of electricity per month are under-electrified<sup>[16]</sup>).

Of the off-grid population, a vast majority (94% or 71 million households) is spread across rural India where the electrification rate dips to 52.5% (Figure 2.1).



Source: International Energy Agency, Intellect analysis

Figure 2.1: Rural-urban distribution of off-grid households in India (2008)<sup>[17]</sup>

[14] Average household size in India is 5.3 person/HH.  
Source: Census 2001

[15] World Energy Council's minimum level of modern energy services for a household per month is 50 kWh

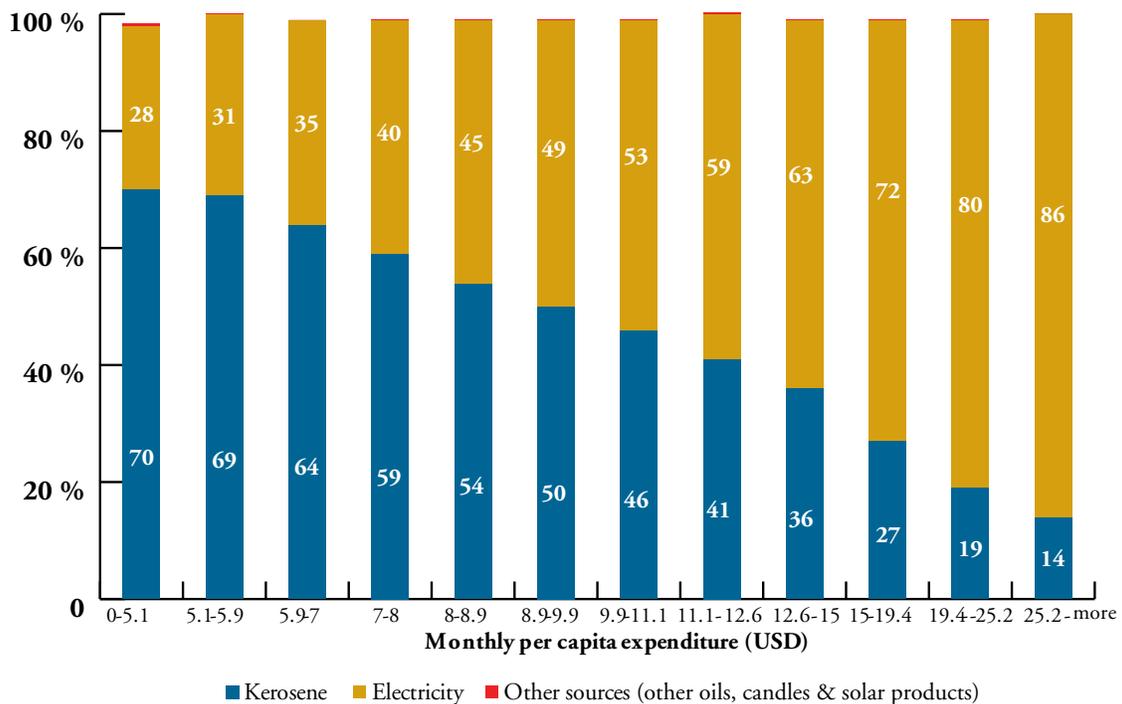
[16] Under-electrification as presented here does not distinguish between unreliable grid supply and low usage of power by the household. The extent of under-electrification is estimated to be around 420 million people in 2005. Source: "Overview of Indian Energy", Prayas Energy Group

[17] 2009 International Energy Agency data is available for overall electricity access for Asian countries in this report, but the rural and urban electrification rate distinction is not available for 2009. Due to this, the report refers to 2008 data for which this split is available

## Kerosene is the dominant source for lighting in off-grid households

Kerosene is the most commonly used source of lighting by off-grid and under-electrified rural households, across income segments<sup>[18]</sup>. As the household income decreases, the percentage of households using kerosene for lighting increases, as shown in Figure 2.2. Kerosene expenditure<sup>[19]</sup> for lighting constitutes 0.6% - 2.1% of the monthly expenditure of rural households and sees a decrease as a percentage of household consumption with rising income levels.

Kerosene is predominantly used for lighting in seven low-income states – Bihar, Uttar Pradesh, Jharkhand, Orissa, Assam, West Bengal and Rajasthan. These states collectively account for two-thirds of the total off-grid rural households (or approximately 50 million households) in India (Figure 2.3 (next page)).



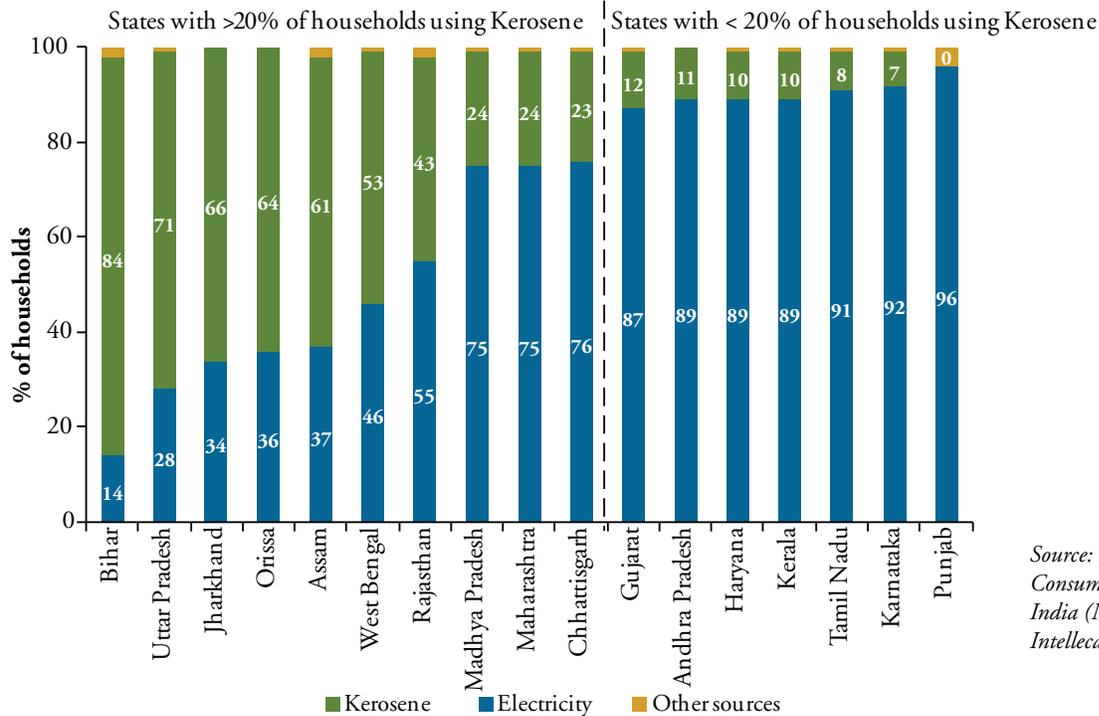
**Note:** Monthly per capita expenditure is used as an indicator for income

Source: *Energy Sources of Indian Households for Cooking and Lighting (NSSO) (2007)*, Intelicap analysis

**Figure 2.2: Distribution of primary sources of lighting in rural India (2004-05)**

[18] The segments on the X-axis of the chart represent monthly expenditures that are assumed to be proportional to the corresponding monthly incomes

[19] The kerosene expenditure is based on Public Distribution System (PDS), which is the subsidized kerosene



Source: Household Consumer Expenditure in India (NSSO) (2010), Intellect analysis

Figure 2.3: Primary sources of lighting in households across states (2007-08)

### Total annual expenditure on kerosene for lighting is USD 2.2 billion

The annual expenditure on kerosene for lighting by off-grid and under-electrified households in India is estimated to be approximately USD 2.2 billion, of which USD 1.8 billion is spent by rural households. The total expenditure is estimated by considering the weighted average of the kerosene price, based on the prices of kerosene sold through the subsidized Public Distribution System and that of kerosene sold in the black market.

### Kerosene consumption is driven by heavy subsidization

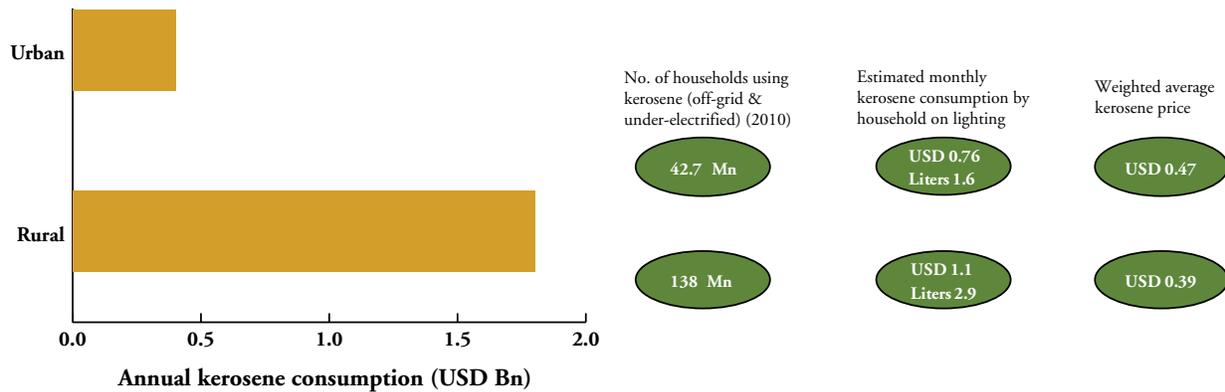
India has one of the highest subsidy levels for kerosene in the world. The government incurs an annual bill of approx. USD 4 billion on kerosene subsidies. Of this, the implied subsidy for lighting is USD 2 billion.

Kerosene subsidy is a highly political subject as the majority of consumers are rural and low-income households, a critical voter base for any political party. Though there have been recommendations that the kerosene subsidies be reduced or phased out, they have never been implemented.

India's budget announcement to move to a direct transfer of cash subsidy holds implications for the solar off-grid lighting market, the exact nature of which will depend on the mechanism of transfer and use of the cash subsidy transferred. It could have a significant positive impact on the market in case the cash subsidy is not linked to kerosene and the consumer is free to choose an energy product.

### Despite high levels of kerosene subsidization, solar off-grid lighting is already a cost-effective option for the consumer

As shown in Figure 2.5 (next page), over a 2-3 year timeframe for lanterns (and 10 year timeframe for SHS), the lifetime costs (product plus battery) for the solar lighting products range from USD 18 to 310. In comparison, kerosene costs (averaging 3-4 liters per month) for the same timeframes are higher at USD 38 to 860.



**Figure 2.4: Annual expenditure on kerosene for lighting by rural and urban households**

Source: UN data, Viable and Sustainable System of Pricing of Petroleum Products(2010), Primary Research, Intelcap analysis

Another measure of affordability is the payback period<sup>[20]</sup>. For a solar lantern, this could vary from 1-2 years depending on the panel wattage of the lantern (ranging from 0.5 Wp to 3 Wp)<sup>[21]</sup>.

For SHS (5 Wp and 15 Wp systems are considered for the analysis), this period ranges from 2-3 years.

These payback periods are estimated using the weighted average price of kerosene. The payback periods will shrink considerably in the scenario of households purchasing kerosene only at black market prices or in the scenario where government withdraws or reduces subsidies.

[20] Period taken by consumer to recoup high initial costs through savings accrued from forgone kerosene consumption

[21] Payback period for households that use unsubsidized kerosene is much shorter (by as much as 3-4 times) as they spend much more in comparison to households that buy subsidized (PDS) kerosene.

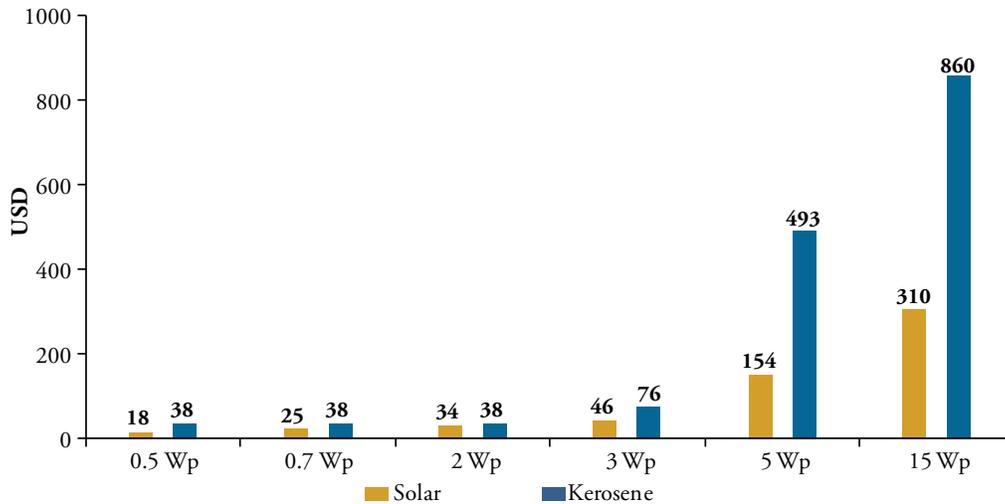


Figure 2.5: Comparison of lifetime costs of solar off-grid lighting products and kerosene lanterns

## 2.2 An overview of the solar off-grid lighting market

### Current market penetration of solar off-grid lighting products is very low

It is estimated that roughly 2 to 3 million solar lanterns and 1 million SHS have been sold to date<sup>[22]</sup> in India. Assuming that there are 75 million off-grid households in India, the estimated penetration of solar lanterns and SHS is extremely low at approx. 4-5%. If the under-electrified households were also taken into account, these penetration levels would decrease further.

There are no clear estimates available on the annual market size for solar lanterns and SHS in India. A recent survey of solar off-grid lighting companies by The Energy and Resources Institute<sup>[23]</sup> (TERI) found that 16 survey respondents sold approx. 270,000 lanterns in 2010. However, this may not be representative of total lantern sales in India, as sales data of enterprises such as D Light and Reliance are not reflected in the survey. In the absence of other sales data sources and based on our

primary research, we estimate that the current annual market size for solar lanterns could range between 300,000 and 500,000 units per annum. Similarly, we estimate that annual sales of SHS could be approx. 100,000 units<sup>[24]</sup>.

### Market led by government efforts until recently

Until 2007-08, the market in India was led by semi-commercial and non-commercial approaches. These were driven by the Ministry of New and Renewable Energy (MNRE), which is responsible for promoting PV systems in the country and oversees programs for promoting solar lanterns and SHS. These programmes did not kick start the commercial market as had been hoped with a still limited penetration rate of solar products.

[22] Please refer to the Appendix for the detailed methodology and the assumptions

[23] TERI is an independent, not-for-profit, research institute focused on energy, environment and sustainable development, devoted to efficient and sustainable use of natural resources

[24] A Solar lanterns of 0.5 to 2 Wp is assumed to replace 1 kerosene lantern, a 3 Wp lantern to replace 2 kerosene lanterns and SHS of 5 Wp and 15 Wp- 3 kerosene lanterns

Each solar lantern is assumed to have a capacity of 4 litres and households are eligible to buy this quantity at PDS price (USD 0.26 per liter). We also assume that households using more than one kerosene lantern have to purchase additional kerosene at a higher retail price (USD 0.76 per liter). Also, please refer to the Appendix (9.9, page-117) for the detailed methodology and the assumptions



*Photo A. Jacobson*

## Summary of MNRE solar lantern and SHS programs

### Solar lantern program:

The program provides solar lanterns to off-grid households through a grant subsidy of approximately USD 52 per lantern to households in off-grid villages identified as a 'special category'. The subsidy is provided through State Nodal Agencies (SNAs) and exclusive retail outlets called Akshay Urja Shops. The cumulative number of lanterns distributed through this program (2010) is approximately 800,000. Primary research indicates that this program will be merged with the new government led Jawaharlal Nehru National Solar Mission (JNNSM) program.

### Remote Village Solar Lighting Program (RVSLP):

RVSLP aims to provide a single-light SHS to 9,000 villages (of 100 households each) that cannot be covered under the government's two rural electrification programs. However, villages covered under the RVSLP will continue to be designated as 'un-electrified'. The program provides subsidy support for up to 90% of the system cost or USD 160 whichever is less. It has distributed 600,000 SHS (2010). This program will be continued as a component of the JNNSM program.

## MNRE subsidy has distorted the market to an extent; going forward, the situation is likely to improve

Some solar companies believe that the market has been distorted by subsidized/free distribution to an extent. Households in certain regions, especially those classified by the government as unreachable through the grid, are aware of the free distribution/subsidy and their purchase decisions have become dependent on the subsidy provision. As a result, cost competitive and good quality products that do not come with a subsidy are not preferred in those regions.

The JNNSM that aims to install 20 million SHSs by 2022, to serve the lighting needs of approximately 100 million people, an ambitious target. At this stage, even though the specifications for receiving MNRE support under JNNSM are not clear, manufacturers are optimistic that the specifications will not be as restricting in nature as earlier. There is also an ongoing dialogue between manufacturers and the MNRE on the specification requirements.

### Strong emergence of private sector models

An increasing number of companies are looking to serve the market by adopting pure commercial approaches i.e. by not depending on MNRE subsidy support. This segment of companies is characterized by young SMEs, most of which have been in operation for less than 5 years. These companies have especially contributed to the increase in sales of solar lanterns in the last 2-3 years.

Most of these companies focus on the solar lantern market and undertake their own product R&D. They develop products that currently do not meet subsidy requirements, but are significantly cheaper and offer a better or an equivalent performance to that of MNRE-certified products. For instance, MNRE primarily promotes CFL based lanterns, which have a luminosity of approximately 370 lumens and are typically priced at USD 90-100. However, there are LED based lanterns available today that do not meet the subsidy requirements, but deliver equivalent lumen output and are priced at around USD 50-60. The lower cost of manufacturing such products

is driven by the efficiencies through better product components and innovative product designs.

### 2.3 Demand scenario

#### The Indian market offers significant potential for solar lanterns and SHS

Based on our primary research with companies, households earning less than USD 65 per month are targeted primarily for lanterns and they do not constitute the target customer segment for SHS. As shown in the Figure 2.6, the target income segment for SHS ranges from USD 65 and above per month.

The proposed cash transfer subsidy system for kerosene in the 2010-11 national budget may have implications on the target customer segment of solar off-grid lighting. Assuming that the criteria for transfer of the cash subsidy will be possession of a Below the Poverty Line (BPL) card,

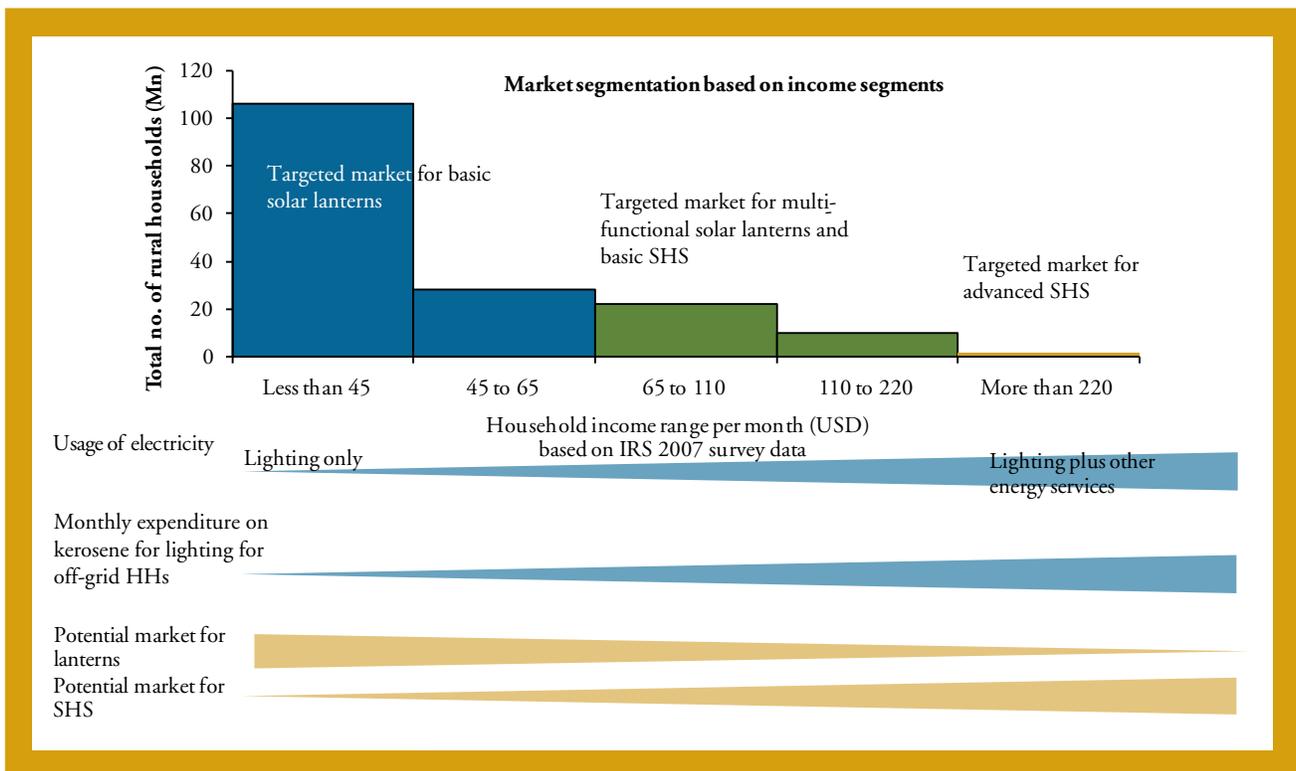


Figure 2.6: Market potential for solar lanterns and SHS in rural India

an estimated 50-55 million households<sup>[25]</sup> who currently enjoy the kerosene subsidy, are likely to be excluded from the scheme. In such a scenario, they will be an attractive customer segment for solar off-grid lighting companies.

### Consumer preferences and needs for solar off-grid lighting are highly localized

Consumer preferences are seen to vary with location and profession. For instance, street hawkers and farmers have varied product preferences. As higher customization adds to costs, some enterprises are working on modular designs that can be used to produce customized systems at reduced cost.

An example of a product that is designed to address varied consumer preferences is a solar lantern with long range focus manufactured by InteliZon. The product can be used to both illuminate a room and as a torch for farmers when they are in the farm fields during early mornings and evenings.

SELCO<sup>[26]</sup> offers customized SHS based on consumer needs. Their portfolio includes approximately 20 SHS variants to cater to different customer segments and usage requirements.

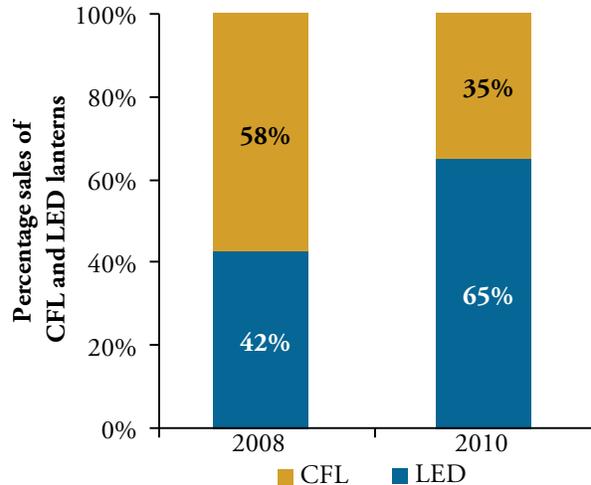
## 2.4 Supply scenario

### Fragmented solar lantern market

Though the solar lantern market in India is characterized by a large number of enterprises, both small and large, there is still vast untapped market potential. The industry is fragmented with no clear leaders in the space. Multinational enterprises such as Philips and Schneider have also only recently entered the market.

[25] According to NSSO 2004-05 survey, approx. 104 million rural households purchase subsidized kerosene and approx. 18 million purchase both subsidized and unsubsidized kerosene. However, the number of rural BPL cardholders is estimated to be approx. 70 million. This implies that the number of rural households purchasing subsidized kerosene without BPL cards could be in the range of approx. 50-55 million

[26] SELCO is a social enterprise, which provides sustainable energy solutions to the under-served households and businesses. Focused in the state of Karnataka. SELCO is prominent in the SHS market



**Note:** About 20 lantern manufacturers participated in the 2008 survey and 16 in the 2010 survey

Source: *The Solar Quarterly 2010*, TERI, Intellicap analysis

**Figure 2.7: Comparison between sales of CFL and LED lanterns**

### Increase in the market share of LED lanterns compared to CFL lanterns

In the recent years, manufacturers have moved from CFL lanterns to LED lanterns, this trend is partly due to the fact that some LEDs can be more efficient but also because of their scalability and the relative flexibility in altering the directionality of LEDs of the higher efficiency of LEDs and their greater lumen package, which decreases the cost of production. Besides, consumer preference towards LED lanterns is on the rise due to their higher performance of battery life, ease of use, lightweight and robust build which are all preferable for rural conditions and for portable applications. Currently, 3 Wp LED lanterns dominate the market with their prices<sup>[27]</sup> varying from USD 20 to 70.

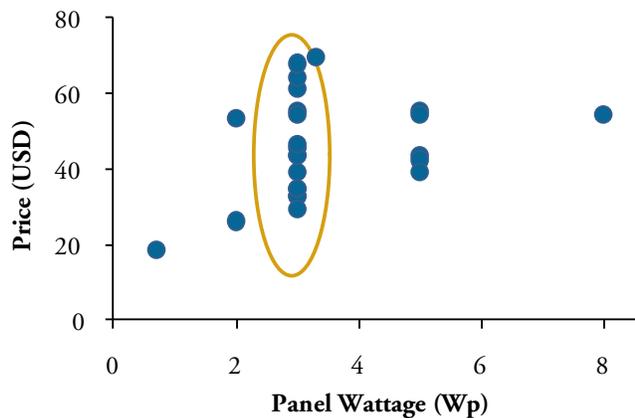
Having said that, some consumer segments still prefer CFL lighting due to higher brightness level perception and better color temperature. For instance, SELCO has observed that micro-entrepreneurs preferred CFL lighting as they feel it lights up their stalls better.

[27] Please refer to the Appendix for the price points of various LED based lanterns available in the market

## There are huge variations in price, quality and performance among LED-based solar lanterns

High levels of variation are observed in the price-performance ratios of different LED lanterns available in the market today. The LED lamp wattages in the market range from 0.5 to 5 Wp, with lumen<sup>[28]</sup> output ranging from 55 to 450 lumens and LED efficacy from 20 to 110 lumen/watt. The performance of electronic circuits in these lanterns also varies widely with respect to charging, efficiency and type of circuit protection.

Of course, consumer benefits and acceptance are also influenced by less technical aspects such as product design, ergonomics and usability. Currently there is no quality assurance standard for consumers in India (status 2102)<sup>[29]</sup>. The MNRE specifications for the subsidized products prescribe not just quality but also very specific performance and design aspects.



Source: *The Solar Quarterly 2010, TERI, Intellectap analysis*

**Figure 2.8: Price vs. panel wattage of LED lanterns**

[28] A lumen represents a specific perceived amount of light, and takes into account the sensitivity of the human eye (the eye is more sensitive to green light and less sensitive to deep red and deep blue/purple). Luminous flux, measured in lumens (lm), is typically used to describe the total amount of light that a light source produces in all directions. Source: [www.LightingAfrica.Org](http://www.LightingAfrica.Org) Briefing Notes

[29] Bureau of Indian Standards is developing a quality assurance framework for LED products (status January 2012)



Image courtesy of SELCO

## SHS market dominated by a few enterprises

The SHS market is comprised of established enterprises such as Tata BP Solar and SELCO on one hand, and small emerging companies such as Duron, ONergy, Barefoot, and Advait on the other. Large multinationals such as Schneider and Philips are recent entrants to this market. Currently, Tata BP Solar is the largest player in the SHS category with approximately 25-30% market share.

## A wide range of SHS products available in the market

CFL and LED-based SHS are available in the market with the latter emerging as the dominant product. The panel wattage of products in the market varies from 2.5 Wp to 75 Wp with corresponding prices<sup>[30]</sup> varying from USD 40 to 600. A majority of products are priced in the USD 150-200 range. Some companies are striving to bring down the cost of the SHS to introduce low-priced but good quality SHS to serve the needs of low-income households.

[30] Please refer to the Appendix for the price points of various SHS available in the market

### India offers local manufacturing capacity of key components except for LEDs

There is an adequate manufacturing capacity of PV components in India. There are 9 companies producing solar cells and close to 20 companies producing solar panels. Annual growth of domestic production of panels has been 20-25% the last few years, with one-third used for solar off-grid lighting.

However, this manufacturing capacity is currently under-utilized with most solar manufacturers operating at only 40% capacity.

Most solar off-grid lighting companies undertake product design in-house and procure the key components such as panels, batteries, controllers and housing domestically and only import LEDs. Such companies also assemble locally. Smaller companies do not assemble the products, instead importing the products in an assembled or in a CKD/SKD<sup>[31]</sup> form, mainly from China and Taiwan.



*Image courtesy of Schneider Electric*

[31] CKD stands for Completely Knocked Down and SKD stands for Semi Knocked Down

## Distribution models adopted by companies in India

Model	Prominent examples
<b>Institutional partnerships</b>	<p>Following are the three different types of institutional partnerships:</p> <p>Partnership with another organization to piggyback on its distribution channel: Examples – D.Light with ITC e-Choupal<sup>[32]</sup>; Visual Lighting Equipment (VLE) and Schneider are evaluating battery manufacturers for potential partnerships</p> <ul style="list-style-type: none"> <li>Partnership with local entities: Example – Tata BP Solar with Ramakrishna Mission Solar Energy Unit in West Bengal, which provides installation and after-sales service through village youth clubs</li> <li>Partnership with third party service providers who undertake distribution, after sales service, consumer awareness programs and promotion of solar lighting products. For instance, ONergy, a company based out of East India provides these services for Barefoot Power by setting up Renewable Energy Centers</li> </ul>
<b>Company owned branches</b>	<p>SELCO is the most prominent in this category. With 25 branch offices and 150 branch staff, SELCO has focused its operations in the state of Karnataka</p>
<b>Micro-franchising</b>	<p>An example of company relying on micro-franchising model is Greenlight Planet</p> <p>Distribution and sales are conducted through micro-entrepreneurs, who are well-known in their villages</p>
<b>Traditional distribution channel</b>	<p>A variety of companies from large ones such as Tata BP Solar, Philips, and Schneider to SMEs such as Solkar, Duron and Advait Energy adopt this. For example: Tata BP Solar has 150 exclusive distributors throughout India</p> <ul style="list-style-type: none"> <li>Apart from regular electrical and consumer durable shops, innovative channels such as chemists and meat shops are also being tried out</li> <li>A dominant player like Tata BP Solar dictates credit terms to distributors whereas some of the new and smaller enterprises need to work with existing credit terms</li> </ul>

[32] E-Choupal is an initiative to link farmers and the agricultural markets via the internet mainly for procurement



*Image courtesy of Schneider Electric*

### Companies partner with MFIs and Regional Rural Banks for consumer financing

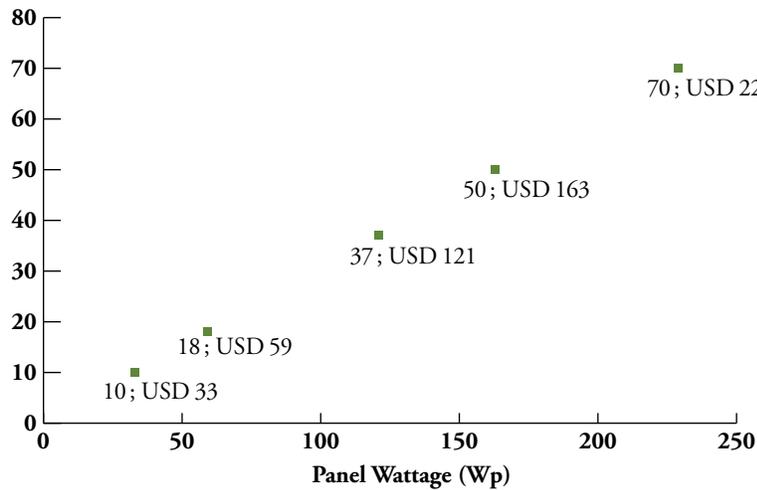
Since the loan size for solar lanterns is too small for commercial banks, solar lantern companies have partnered (or are attempting to partner) with MFIs for providing credit to consumers.

The lantern loans offered by MFIs are typically provided as top-up loans<sup>[33]</sup> to the regular income generation loans.

[33] Top-up loans are loans provided to existing loan customers having a good credit history

The loan tenure varies from 6 months to 1 year depending on the loan size with an interest rate close to that of their existing loan products. Certain MFIs also assume the responsibility of sales and distribution as they are closely connected to the local communities.

In the case of SHSs, MFIs are currently not a major source of consumer financing for SHS because of the larger loan size requirements and related risks. After-sales service is also more critical in case for SHSs and MFIs face a higher risk of loan default in the absence of effective after-sales service.



Wattages	10W	18W	37W	50W	70W
Typical Retail Price	~USD 130-170	~USD 150-220	~USD 270-330	~USD 500-600	~USD >550
Capital Subsidy	USD 20	USD 35	USD 73	USD 98	USD 137

Figure 2.9: Mapping loan amounts against the SHS panel wattage under the JNNSM program

**The government led JNNSM program<sup>[35]</sup> is expected to push consumer financing for SHS; however, there are concerns on the adequacy of financing**

Enterprises have partnered (or held discussions) with MFIs to offer consumer finance for their SHSs. However, most partnerships have not been successful due to various challenges faced by the MFIs, such as credit risk, brand risk (if consumers start associating faulty product with an MFI), cost of funds especially when directed in non-income generating loans, high transaction costs for low-cost products and lack of sales and distribution capability. A majority of the lantern and SHS enterprises are still looking to leverage the MFI channel for end-consumer financing, given its unique set of advantages such as last mile reach, captive client base, consumer trust and low cost of sales and distribution. However with the recent regulatory uncertainties<sup>[34]</sup> around MFIs the potential of this channel is expected to be in question.

The program makes a provision for institutionalizing the consumer financing mechanism for SHSs through commercial banks, regional rural banks and non-banking finance companies (NBFC). The program assumes a benchmark price of SHSs to be USD 6.5/Wp, i.e. a 10 Wp SHS is assumed to be available at USD 65 in the market. 30% of the benchmark SHS price will be offered as capital subsidy and 50% of the price is to be financed by banks at an interest rate of 5%. However, there is ambiguity on this financing provision, as the SHS typically costs more than the benchmark price assumed by MNRE – for example, the minimum price of a 10 Wp SHS in the market is USD 175, much higher than the benchmark price of USD 65. Credit through Regional Rural Banks (RRBs) and commercial banks are on hold until there is greater clarity on this.

[34] Refer to whitepaper published by Intellectap on implications of MFI regulatory changes - <http://goo.gl/7NM2g>

[35] See Appendix for further details on the program

## Traditional debt financing a challenge, but new funding facilities are emerging

Most of the solar lighting companies are young SMEs needing both working capital and growth capital to scale up. However some companies are unable to raise debt financing due to the following reasons:

- Solar off-grid lighting SMEs usually require debt of less than USD 1 million which falls below the typical loan amounts offered by banks
- Bank financing is available only if the company shows three years of continuous profitability
- High fixed asset collateral requirements of banks and their unwillingness to accept product inventory (SHS and lanterns) as collateral
- Poor quality of financial management in some of the SMEs

There is limited information/understanding of the business models for these companies and no readily available financial benchmarks that banks can use to understand working capital and fixed investment needs. This information asymmetry further increases the risk perception held by banks.

There are ongoing efforts to increase access to debt financing. In 2010, the Shell Foundation partnered with Intellectash, a wholesale and retail lending NBFC, to establish a credit facility for SMEs in the clean energy space which has now been moved to the NBFC “Intellegro”. The facility will provide short-term loans at competitive interest rates for a tenure of less than one year, with no collateral or three-year profitability history requirements. The maximum loan size that can be accessed under this facility is approximately USD 220,000.

There is also the recently launched Oasis Energy – Solar for All Fund which is the first specialized sector fund for solar energy investments at the Base-of-the-Pyramid. The Fund will be a global fund investing in solar energy companies whereby investments will be made as equity or debt in companies across the PV supply chain, from manufacturing and distribution to end-user finance. Investments will be in the range of USD 0.5 - 4 million, and the Fund will be looking to co-invest alongside other partners.

## Companies attracting equity funding

Until recently, there was very limited venture capital (VC) and private equity (PE) activity in the renewable energy space, but the situation is gradually changing. Dedicated VC/PE funds have been formed for investing into clean energy companies and solar lighting is beginning to be recognized as a clear opportunity. Examples of such funds include: Climate Change Capital, Aloe and Nexus.

Some off-grid lighting companies have been quite successful in attracting private equity investment. Following are some examples: Acumen, Omidyar Network, Nexus, Gray Matters Capital, Draper Fisher Jurvetson (DFJ) are among the investors who have invested in D Light; E+Co invested into SELCO; Venture East invested into IntelizOn.

Equity investments into solar are pouring into large scale PV projects, but there is a plenty of scope for investments into solar off-grid lighting SMEs if some of the key concerns of investors are addressed:

- Investors in this market have expressed concerns that most companies do not have robust distribution and after-sales service models yet, which are critical to scale
- Perception that the margins would be low in serving the base-of-the-pyramid market
- Low visibility for an investor into exit options

Some of the companies also highlighted the important role that needs to be played by emerging paradigms of impact investments<sup>[36]</sup> and patient capital that can handhold the sector in its current stage.

## Scope for companies to explore carbon-financing mechanisms

Some companies are looking to leverage carbon finance markets to partly meet their financing need. This is strengthened by the United Nation’s Framework Convention on Climate Change (UNFCCC) having an approved methodology for carbon financing for solar

[36] Investors focused on impact investments aim to make positive social/environmental gains alongside profits through their investments

lanterns, based on Lighting Global’s quality standards. Literature review and primary research suggests that carbon revenue is typically channeled towards product promotion and strengthening of after-sales service by companies that receive them.

## 2.5 Overview of regulatory environment

### Kerosene subsidies are the biggest regulatory hurdle

The MNRE has been creating a conducive environment for the solar off-grid lighting market. Low to nil duties on components and favorable taxation policies are indicative of its efforts. The huge kerosene subsidy however remains a key barrier, stopping the full potential of the market being achieved.



Image courtesy of Schneider Electric

Overview of regulatory environment - India			
	Status	Impact on SHSs	Impact on solar lanterns
<b>Financing support – Solar lighting products</b>	<ul style="list-style-type: none"> <li>MNRE offers capital subsidies on SHS and lanterns. Provision for consumer financing for SHS under the JNSSM program</li> </ul>	<ul style="list-style-type: none"> <li>JNNSM has aggressive targets for SHSs, and is expected to propel the market through easy financing for SHSs</li> </ul>	<ul style="list-style-type: none"> <li>MNRE focus on Solar lanterns has reduced</li> </ul>
<b>Subsidies – conventional fuels</b>	<ul style="list-style-type: none"> <li>Government offers a subsidy of 0.5 USD per litre. The kerosene price pre-subsidy is USD 0.8 and post-subsidy is 0.3 USD per litre</li> </ul>	<ul style="list-style-type: none"> <li>Kerosene price is highly subsidized reducing the competitiveness of the solar products</li> </ul>	
<b>Import tariffs and duties</b>	<ul style="list-style-type: none"> <li>No import duty for solar cells, modules, panels, LEDs and charge controllers<sup>[i]</sup>, 10% import duty on batteries and 5% solar lanterns</li> <li>Ambiguous codes are applied leading to different import duties</li> </ul>	<ul style="list-style-type: none"> <li>No import duties on PV modules and LEDs supports local assembling of SHS</li> </ul>	<ul style="list-style-type: none"> <li>Import duties on solar lanterns discourages imports of good quality lanterns</li> <li>Import procedures and codes applied are ambiguous and marred in red-tape</li> </ul>
<b>Taxation policies</b>	<ul style="list-style-type: none"> <li>5% VAT as opposed to higher rates for other products and services</li> <li>No industrial clearances required</li> <li>Central excise duty exempted</li> <li>Financial support is available for the PV industry for R&amp;D projects in association with technical institutions</li> <li>Proposals for up to 100% FDI in a JV qualify for an automatic approval</li> </ul>	<ul style="list-style-type: none"> <li>Encouraging regulatory environment for manufacturers and investors (domestic and foreign) to enter solar market and set up capacity</li> </ul>	

[i] For all the countries except Bangladesh, customs duty on charge controllers is considered as customs duty applicable on controllers under the category ‘electronic integrated circuits’.

Sources: India Customs Tariff, Primary research

## 2.6 India conclusion

With approximately 400 million people off the grid and many more under-electrified, India offers a tremendous potential for the solar off-grid lighting market, given the minimal market penetration. Off-grid lighting products are affordable over a period of time despite the significant subsidy given for kerosene by the government. Other positive factors are the presence of local manufacturing capacities, favorable regulatory scenario, new financing models that are being piloted and the transition of the market from a 'subsidy driven' to a 'strong private sector led' market.

To realize the market potential, companies need to meticulously formulate their distribution and after-sales service strategies and collaborate with partners on ground to deliver the marketing messages in a localized manner.

### 3. Bangladesh Market Scoping

#### 3.1 The current state of off-grid lighting

Bangladesh has population of 163 million (or 29 million households) and a low electrification rate of 41% with 17 million households being off-grid. Of the off-grid population, a vast majority (89% or 15 million households) is concentrated in rural Bangladesh where the electrification rate dips to 28% (Figure 3.1). A large segment of the on-grid population is also under-electrified, facing significant daily power outages.

#### Kerosene is the dominant source for lighting in off-grid households

Primary research suggests that there is a heavy dependence on kerosene for lighting in Bangladesh. This is also borne out by a 2004 World Bank study (Figure 3.2) that shows kerosene usage across regions in Bangladesh as high as 90-100% amongst rural households (both off-grid and under-electrified).

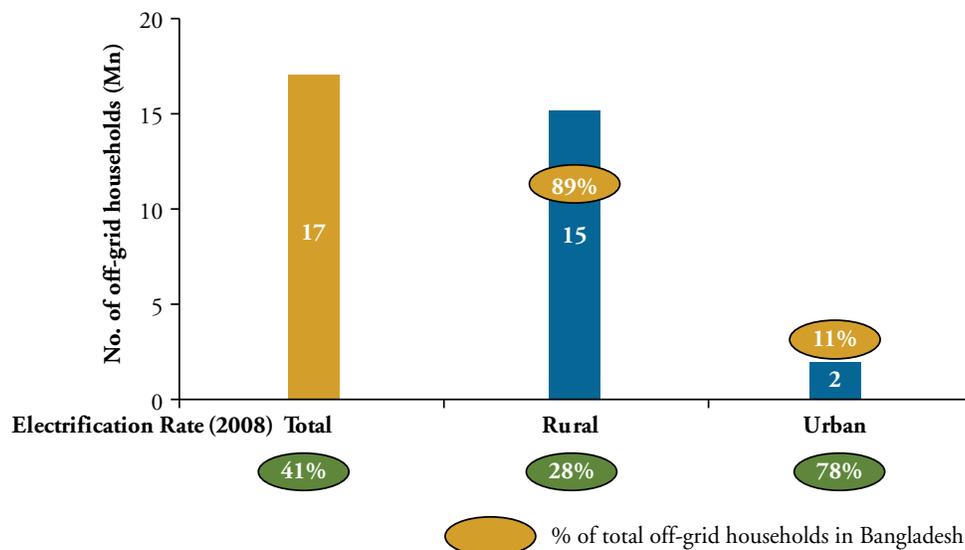
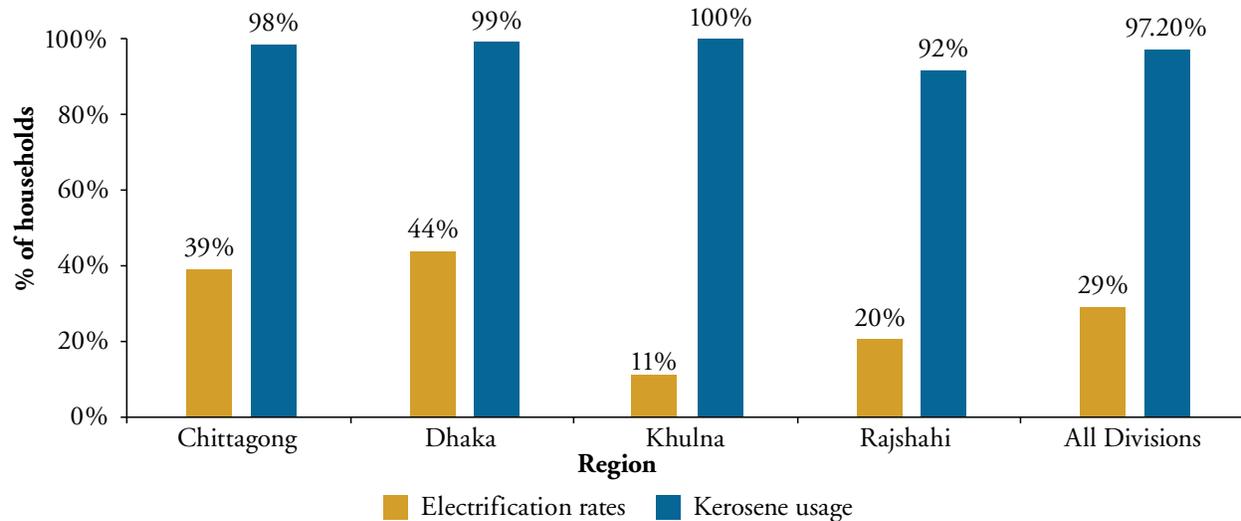


Figure 3.1: Rural-urban distribution of off-grid households in Bangladesh



Source: Bangladesh's Rural Energy Realities (World Bank), Intellecap analysis

**Figure 3.2: Electrification rates and kerosene usage for lighting by region (2004)**

### Total annual expenditure on kerosene for lighting is USD 0.36 billion

The typical expenditure on kerosene is around 1 to 2% of the monthly incomes of Bangladeshi households. With 94%<sup>[37]</sup> of this kerosene being consumed for lighting, the resulting expenditure on kerosene for lighting is approximately USD 0.36 billion.

### 3.2 An overview of the solar off-grid lighting market

#### The IDCOL<sup>[38]</sup> solar program drives the solar off-grid lighting market

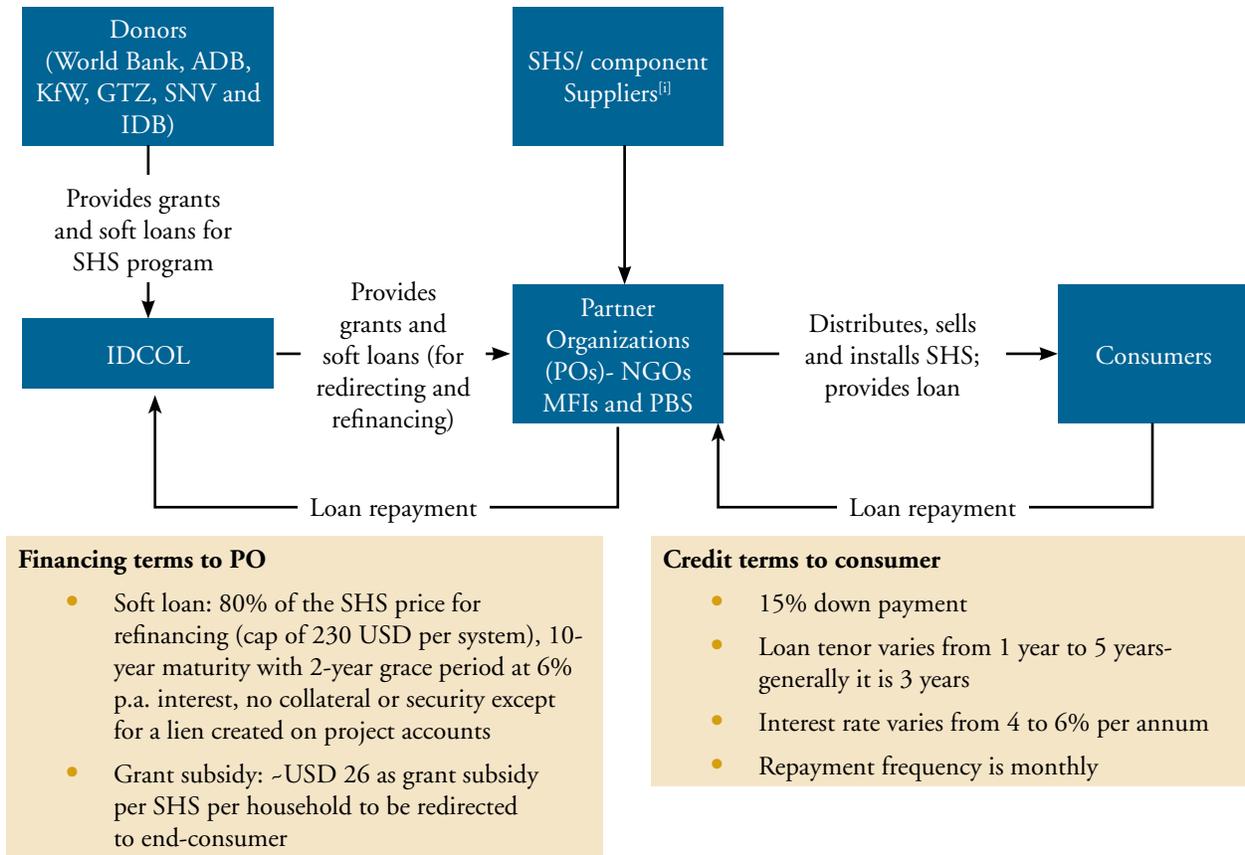
The Infrastructure Development Company Limited's (IDCOL) solar program was launched in 2003 as part of the Rural Electrification and Renewable Energy Development Project (REREDP) of the World

Bank. Currently, the program is operational only in areas recognized as off-grid by the government of Bangladesh (covering approximately 17 million off-grid households). Only SHS are supported in the program as the government considers households using SHS as electrified.

The program works with donor agencies, the SHS suppliers, technical experts and with Partner Organizations (POs) that have experience in micro-credit. To reduce the cost to the consumer, the program subsidizes the upfront cost of the SHS through a grant and provides soft loans to the POs so that the consumers can access credit at low interest rates. The following figure (Figure 3.3) represents the schematic diagram of the program. The common financing types are explained in further detail in this section.

[37] Source: Bangladesh's Rural Energy Realities, World Bank, 2010

[38] IDCOL is a government owned financial institution. One of its mandate is to provide financing for infrastructure and renewable energy projects in Bangladesh



[i] Note: Most NGOs procure components such as solar panels, batteries, charge controllers, lights and assemble SHS such as Grameen Shakti while few others procure complete systems

**Figure 3.3: Schematic diagram of IDCOL solar program<sup>[39]</sup>**

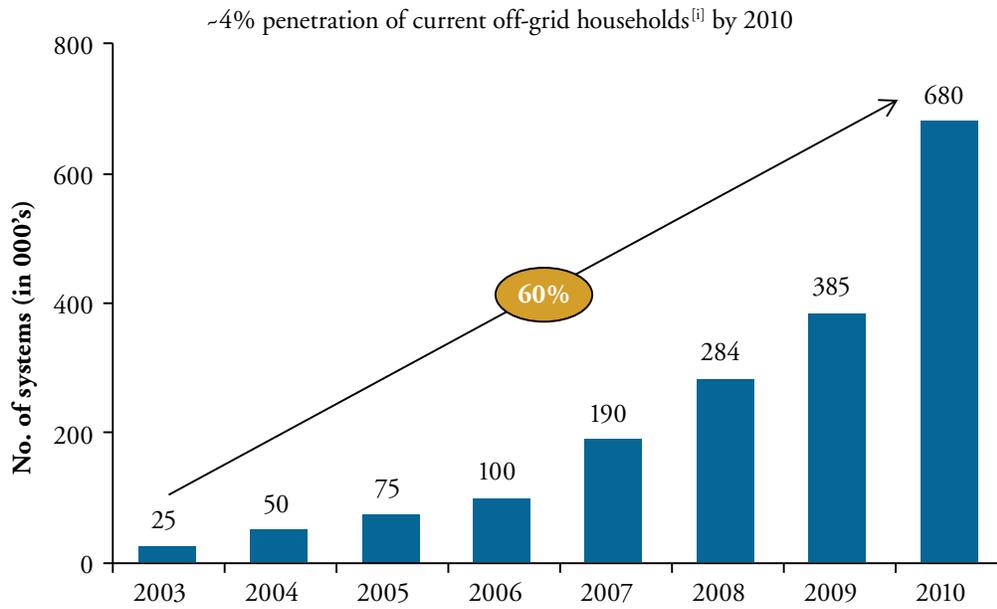
680,000 SHSs have been installed to date under IDCOL's solar lighting program. The program has been quite successful in stimulating the market and driving growth – it has grown at over 60% CAGR since inception and covered 485 Thanas (sub-districts) out of 509 in Bangladesh. However, there is ample scope for further growth, as the current installations imply a market penetration rate of only 4% of the 17 million off-grid households. In contrast, the solar lantern market in Bangladesh is almost negligible.

The program aims to reach a scale of 4 million SHS installations by 2014, implying an annual growth rate of over 115% and a market penetration of approximately 25%. These high projections are going to be driven by the recent inclusion of low-wattage SHS<sup>[40]</sup>. These SHS can be sold aggressively to low-income households.

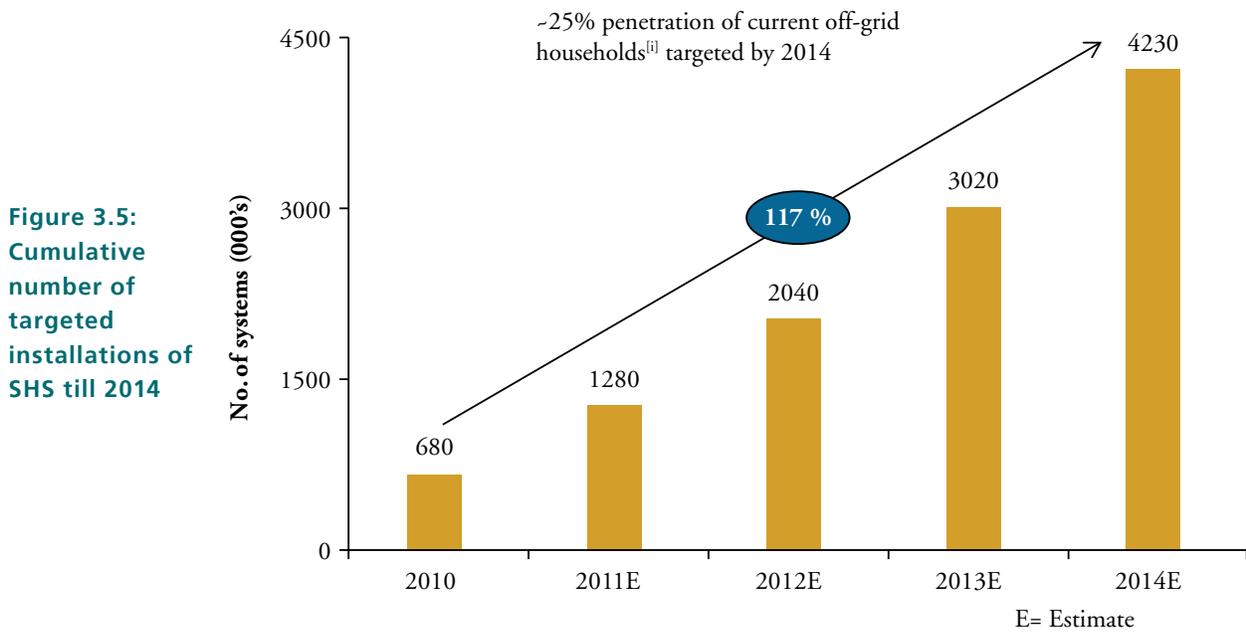
[39] Sources: IDCOL presentation at DIREC 2010; Intelcap estimation and analysis

[40] Until recently, POs were selling SHSs of wattages above 30 Wp through the program

**Grameen Shakti contributes to approximately 64% of the program sales**



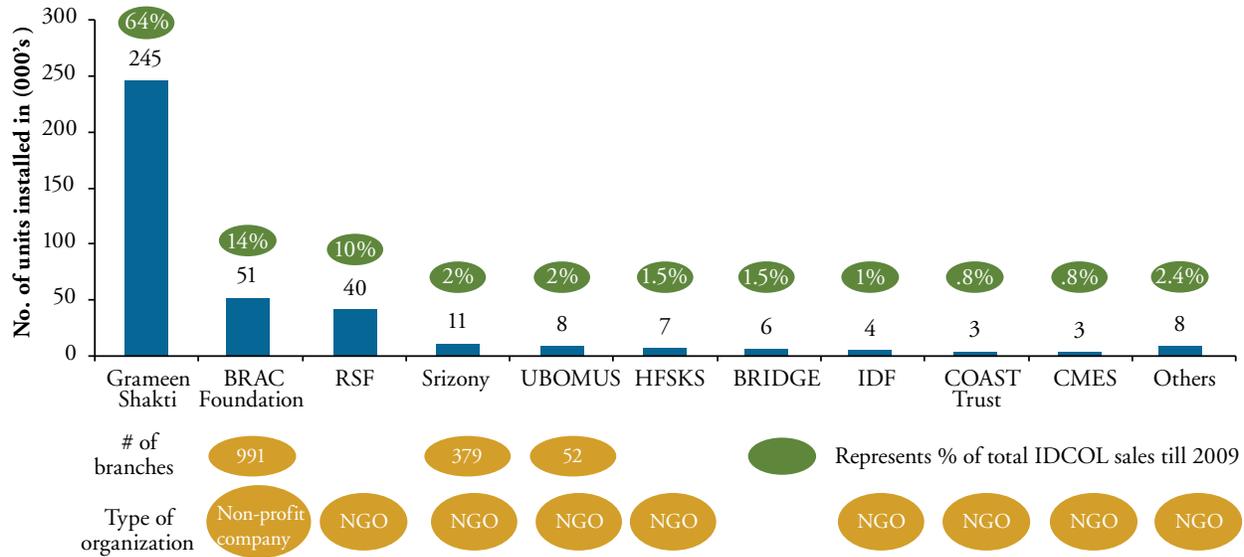
**Figure 3.4:** Cumulative number of SHS installed through IDCOL solar program



**Figure 3.5:** Cumulative number of targeted installations of SHS till 2014

E= Estimate

[i]-17 Million Off-grid households in Bangladesh  
 Source: Overview of the policies - Bangladesh (RENDEV), IDCOL solar home systems model, Financial model design- Bangladesh (RENDEV), Intellectap analysis



Source: Overview of the policies - Bangladesh (RENDEV), IDCOL solar home systems model, Financial model design- Bangladesh (RENDEV), Intellecap analysis

Figure 3.6: Cumulative sales of different POs (2009)

The number of Partner Organizations (POs) has risen from 5 in 2002 to 30 in 2011. Of all the POs, Grameen Shakti (GS) is the most prominent one, accounting for 64% of the SHS installations so far. The reasons for its dominant position in the market are:

- An extensive network and outreach: Grameen Shakti has a deep rural network with 991 branches; it has coverage across all the districts and approximately 40,000 villages (approximately 50% of villages) in Bangladesh
- Consumer trust and goodwill: Grameen Shakti enjoys first mover advantage as it has been working in this market from 1996 and has built the SHS market from the ground-up. It has also created a strong awareness amongst people about SHS and its benefits
- Strong sales and after-sales network: Grameen Shakti has significant trained manpower for

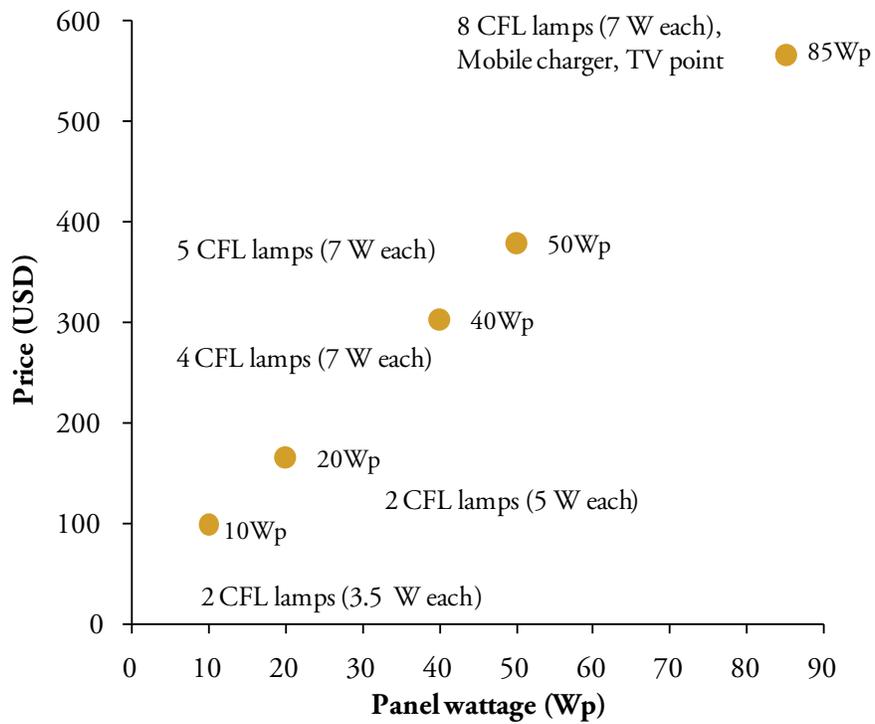
production, installation and after-sales service with approximately 7,500 trained technicians. It has also established Grameen Technology Centers to train and recruit locals as solar technicians

- In-house assembly of SHS: Grameen Shakti assesses the needs of the consumers and then designs and assembles the appropriate SHS through its 15 manufacturing units in rural areas and 1 in Dhaka

80-85% of the overall sales of SHS are in the range of 20-85 Wp with 50 Wp systems accounting for an estimated 35% of all sales. In terms of technology used, larger systems (>20 Wp) primarily use Linear Fluorescent Lamps (LFL). However, our research suggests that there is a shift to CFL with 20 Wp systems available today being primarily CFL-based. There is no noticeable penetration of LEDs yet. Once systems with a Wp of lower than 20 Wp are introduced, they are expected to be LED based.



Image courtesy of Grameen Shakti

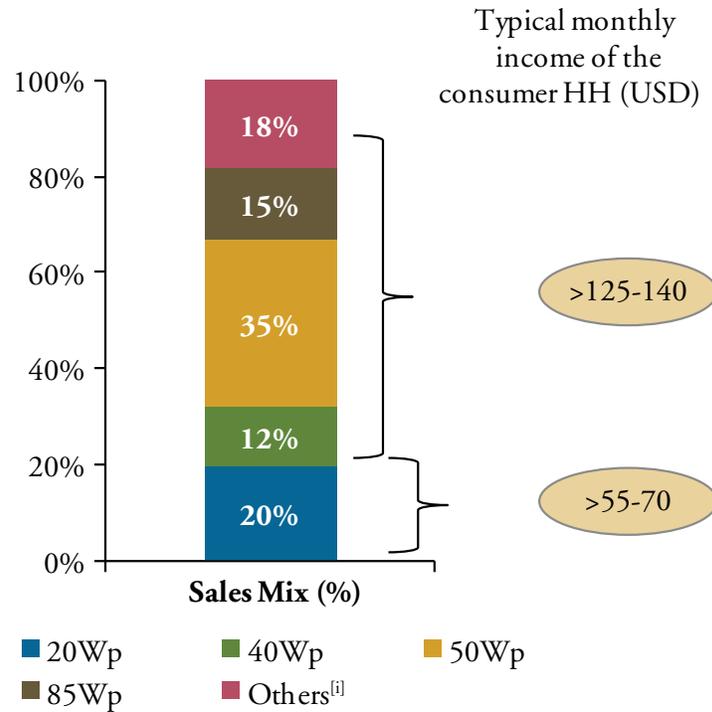


Source: Primary research, Intellectap analysis

Figure 3.7: Mapping product features and prices of SHS

As shown in Figure 3.8, more than 60% of the systems are sold to households earning more than USD 125 per month. 20 Wp SHS, specifically introduced to cater to

the income segment earning between USD 55-125 per month, constitutes approximately 20% of the overall SHS sales.



[i] Others includes <20 Wp and >85 Wp systems

Source: Primary research, Intellectap analysis

**Figure 3.8: Sales mix of SHS and mapping against the consumer household income segment**

Grameen Shakti and the Rural Services Foundation (RSF) have introduced systems with wattages of less than 20 Wp, such as 10 Wp and 7.5 Wp SHS. The key issue is the low battery life of these systems. Battery life is a critical factor for the POs to manage credit default risk. This is because the loan tenures of POs are usually less than or equal to the battery life to ensure consistent repayment from the consumers.

As batteries in the low wattage systems do not allow the POs to offer loans at standard tenure (2-3 years), they have to reduce the loan tenure to match the life of the batteries (less than 1 year). This means that the financing terms of POs become unattractive for low-income households. This is the reason Grameen Shakti has temporarily withdrawn from promoting the 10 Wp system.

## Easy consumer financing is one of the key reasons for high uptake of SHS

Easily available financing has allowed solar to be cost-competitive to conventional sources of lighting such as kerosene. The typical consumer financing terms offered by POs under the IDCOL solar program:

- Loan amount of up to 80% of the SHS price (or USD 230, whichever is lower), consumers pay a 15% deposit with the remaining sum being covered by the IDCOL buy-down grant<sup>[41]</sup> (or subsidy) of USD 26 per SHS
- Three-year loan tenure. The loan tenure is set below the duration of the SHS warranty to minimize the default risk in the event of product failure

- Flat interest rate of 4-6% per annum. This is a low interest rate in comparison to the market rates and is made possible by soft financing that POs receive from IDCOL
- Loan repayments on a monthly basis

Following is an illustration of the solar home system's wattage and price, the corresponding income segment and the monthly loan repayments.

Other payment models such as fee-for-service have not been successful in Bangladesh. Consumers did not own the SHS in the fee-for-service model and it led to poor handling and maintenance of the product.

SHS segment (price)	Monthly income of target consumer segment	Monthly repayment by consumer on Solar loan
50 Wp (approx. USD 380)	More than USD 125	approx. USD 9.7 <sup>[42]</sup>
20 Wp (approx. USD 165)	More than USD 55	approx. USD 3.7
10 Wp (approx. USD 100)		approx. USD 1.9 (36 months term) or approx. USD 3.5 <sup>[43]</sup> (20 months term)

[41] A grant given to reduce the upfront cost to be paid by the consumer

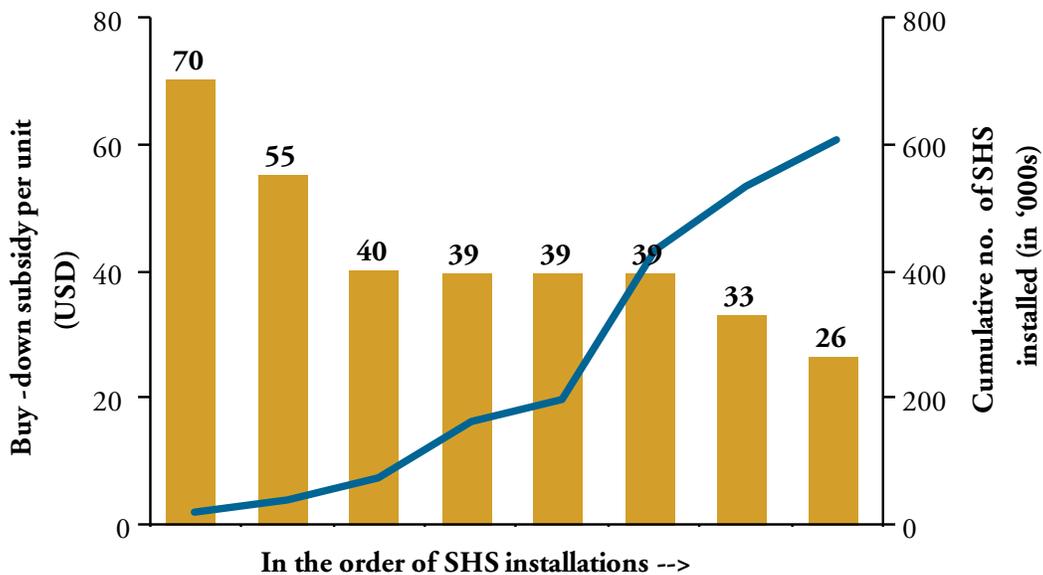
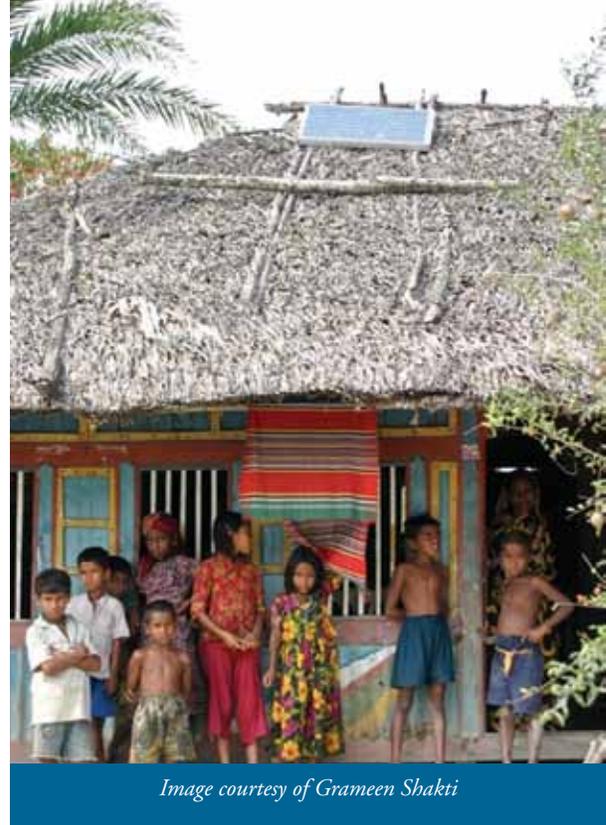
[42] Assuming 6% flat interest rate (effective interest rate would be approx. 12%) and term of 3 years, 15% down payment and approx. USD 29 grant subsidy

[43] Assuming 6% flat interest rate and term of 20 months, 15% down payment and approx USD 26 buy-down subsidy

### Reducing dependence on IDCOL subsidies

The buy-down grant subsidy has reduced from USD 70 to its current level of USD 26 over the last 7 years. A further reduction or a complete phase-out of the buy-down grant is expected in the near term. This is not expected to hurt the market growth as it will be offset by a corresponding reduction in the cost of the systems due to the decreasing trend in component prices.

Primary research with POs suggests that even a complete phasing out of the grant subsidy will not affect growth, as it would result in an effective increase of just around USD 1 in monthly repayments. However, the soft loan facility that has driven consumer financing is expected to continue.



Source: Primary research, IDCOL, Intellect analysis

Figure 3.9: Subsidies provided and the cumulative growth of SHS installed (2010)

### **Solar lanterns market penetration is currently negligible in Bangladesh**

The presence of solar lanterns in Bangladesh is currently negligible. Due to strong promotion of SHS and exclusion of lanterns in the IDCOL solar program, the solar lantern market has not been established yet. POs such as RSF are piloting LED based solar lanterns. These lanterns are affordable, being in a price range of USD 30-40 and would be the best solution for households that cannot afford low wattage SHS. However, battery life and product quality are the concerns that POs have regarding the promotion of the lanterns.

There is an opportunity for enterprises with good quality solar lanterns to enter the market, partner with POs and cater to the lighting needs of the low-income segment.

### **Local panel manufacturing is expected to grow in the next few years driven by market potential**

The Bangladesh solar off-grid lighting industry is heavily dependent on imports for its component and product requirements. Almost the entire requirement of PV panels / modules is currently imported from manufacturers such as India, Japan, China and the United States. Although batteries and charge controllers are mostly locally manufactured, most of their components are imported. In lamps, CFLs are manufactured locally with LED being imported. On the product side, solar lanterns are entirely imported.

However, greater domestic procurement is expected as a domestic solar panel manufacturing and assembly industry is emerging. This is driven by the huge market potential and increasing government support. Rahimafrooz and Allied Solar are among a few local solar manufacturers who are setting up PV panel assembly plants. Through local manufacturing, the market will be assured of a regular supply of panels with lower lead times. However, the ability of the local industry to maintain the quality of components to a level similar to that of international suppliers remains to be established.

### 3.3 Overview of the regulatory environment

The policy and regulatory scenario in Bangladesh is highly favorable for SHS. Consumers are able to access affordable finance and enjoy affordable prices as a result of zero import duty on solar panels. Insignificant subsidy support for kerosene has also ensured that solar off-grid lighting remains competitive for consumers.

Companies have also benefited from the relaxed taxation policies that are encouraging new enterprises to enter the solar off-grid lighting market at different stages of the value chain.

As noted earlier, solar lanterns would be an appropriate solution for households that cannot afford the low wattage systems, such as 20 Wp SHS available in the market today. However, the lack of focus on solar lanterns has been a hindrance to growth in this sector. Solar lanterns face high import duties of 25% and are also hobbled by the fact that they do not enjoy coverage under the IDCOL solar program.

Overview of the regulatory environment- Bangladesh			
	Status	Impact on SHS	Impact on solar lanterns
<b>Financing support – Solar lighting products</b>	<ul style="list-style-type: none"> <li>Solar products made affordable through financing on easy terms through IDCOL's soft-loan program</li> </ul>	<ul style="list-style-type: none"> <li>Program has been a huge success in reaching out to off-grid households</li> </ul>	<ul style="list-style-type: none"> <li>Solar lanterns are not included in the program</li> </ul>
<b>Subsidies – conventional fuels</b>	<ul style="list-style-type: none"> <li>Retail price of Kerosene is ~1.1 USD per litre compared to a subsidized price of ~0.8 USD per litre</li> </ul>	<ul style="list-style-type: none"> <li>The subsidy on Kerosene is not too high to negatively impact SHS / solar lantern adoption</li> <li>IDCOL program has put SHS on a level playing field with Kerosene</li> </ul>	
<b>Import tariffs and duties</b>	<ul style="list-style-type: none"> <li>No import duty on solar photovoltaic cells, modules/panels and LEDs</li> <li>Charge controllers- 40%</li> <li>Batteries- 25% for finished battery; 7.5% for raw lead</li> <li>CFL- 26%</li> <li>25% - solar lanterns</li> </ul>	<ul style="list-style-type: none"> <li>No import duties on PV modules and LEDs supports local manufacturing</li> </ul>	<ul style="list-style-type: none"> <li>High import duties on solar lanterns discourages imports of good quality lanterns</li> </ul>
<b>Taxation policies</b>	<ul style="list-style-type: none"> <li>Renewable energy equipment, related raw materials to produce such equipment is exempted from 15% VAT</li> <li>Renewable energy project investors (public / private) are offered a tax holiday subject to extension based on impact assessment of exemption on renewable energy</li> </ul>	<ul style="list-style-type: none"> <li>Encourages local manufacturers to set up and increase solar PV panel capacity</li> <li>Approval process is not too difficult</li> </ul>	

Source: Literature review, Primary research

### 3.4 Bangladesh conclusion

Approximately 17 million households or 96 million people are off-grid and at least an equivalent number of people are under-electrified. The absence of kerosene subsidies in Bangladesh increases the cost competitiveness of solar lighting products by far compared to kerosene based lighting.

Though the IDCOL solar program has led the way for the solar lighting market, it has achieved only 4% market penetration so far. Even with aggressive growth projections, the IDCOL program can cover only 25% of the off-grid households by 2014. This means that there is a vast under served market for solar lanterns and small SHSs (10 Wp or less), both of which are currently outside the purview of the IDCOL solar program due to shorter battery life and quality issues – issues that have technical solutions.

Moreover, the IDCOL solar program needs to raise approximately USD 400 – 500 million in soft loans to meet their target sales projections by 2014. In the event of IDCOL being unable to raise funds, a significant market disruption can be expected. Private sector enterprises that have affordable products and credit linkages with MFIs in the country can be at the forefront of filling up this gap.

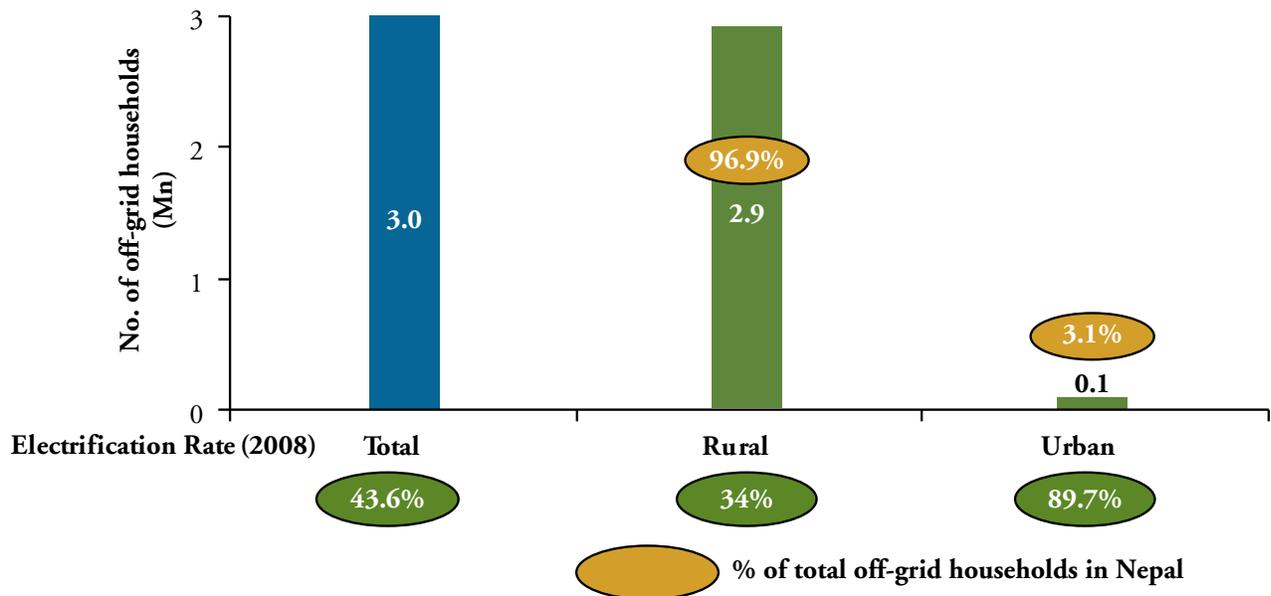
The unique opportunity to leverage PO infrastructure, high consumer awareness of solar lighting and the emerging local PV panel industry position Bangladesh as a key destination for the enterprises keen on tapping the solar lighting market in Asia.

## 4. Nepal Market Scoping

### 4.1 The current state of off-grid lighting

There are 3 million off-grid households in Nepal, the majority (approx. 97%) of which is in rural areas.

The electrification rate in rural Nepal is as low as 34% (in 2008) compared to the national average of 44%. Almost all the on-grid households (approx. 2.4 million) in Nepal face severe power shortages or at least 12-14 hours of load-shedding<sup>[44]</sup> every day<sup>[45]</sup>.



Source: International Energy Agency, Intellecap analysis

Figure 4.1: Rural-urban distribution of off-grid households in Nepal (2008)

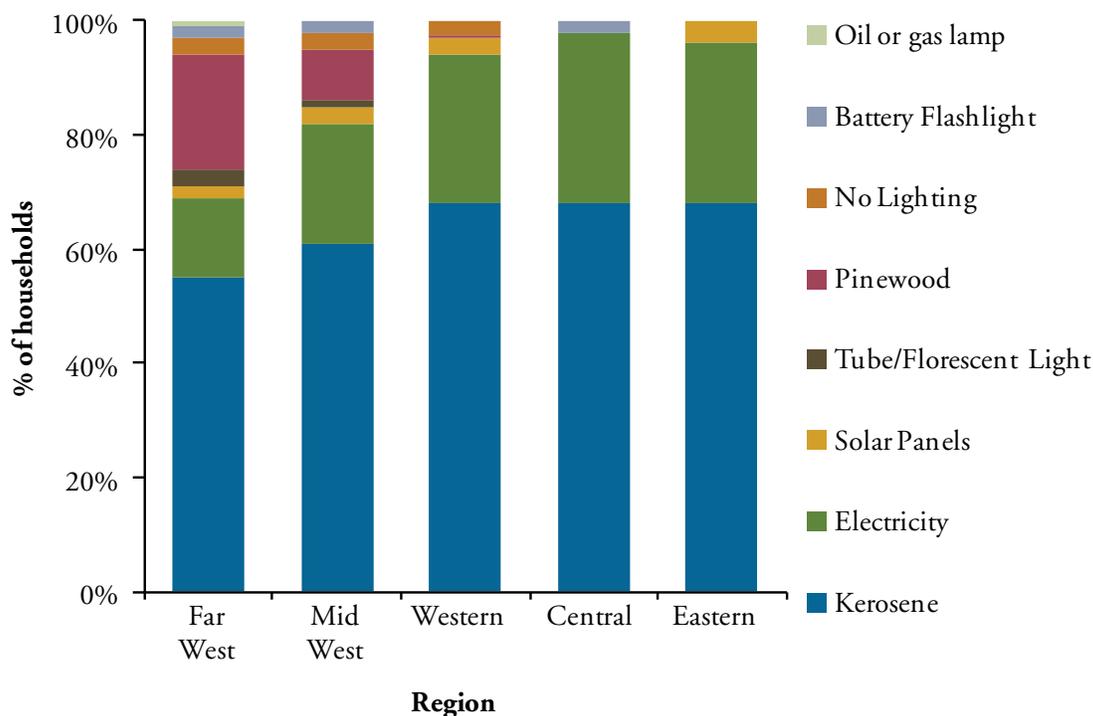
[44] Load Shedding: Power cuts

[45] Source: Load shedding schedule, Nepal Electricity Authority

## Kerosene is the primary source of lighting for these off-grid households

A study conducted by the World Food Program found that kerosene is the predominant source of lighting across all regions in Nepal. Interviews with stakeholders in the solar off-grid lighting industry validate the fact that

kerosene still remains the primary source of lighting for off-grid households and the secondary source of lighting for under-electrified households.



Source: Comprehensive Food Security and Vulnerability Analysis (World Food Programme)

Note: Graph is approximate as the graph has been created based on a chart image

**Figure 4.2: Primary sources of lighting in rural households of Nepal (2005)**

With 90%<sup>[46]</sup> of kerosene consumption going for lighting, at a current price of approximately USD 0.9 per liter, an estimated USD 0.19 billion is spent on kerosene for lighting. This is a conservative estimate, since in remote regions of Nepal, the kerosene price increases drastically up to approximately USD 2 per liter due to lack of road infrastructure and corresponding distribution challenges.

With nearly all households (off-grid and under-electrified) using kerosene, 0.19 billion translates into an approximate expenditure per household of USD 2.9 (3% of rural household expenditure<sup>[47]</sup>), or an average 3.2 liters of kerosene consumption per household per month.

[46] Kerosene is primarily used for lighting; Most common cooking sources in Nepal are biomass and biogas

[47] Based on expenditure of lowest income quintile

## 4.2 An overview of solar off-grid lighting market

The Nepalese market for solar off-grid lighting is dominated by SHS. The market has a unique product that is known as “Solar Tuki” which is a Small SHS (SSHS).



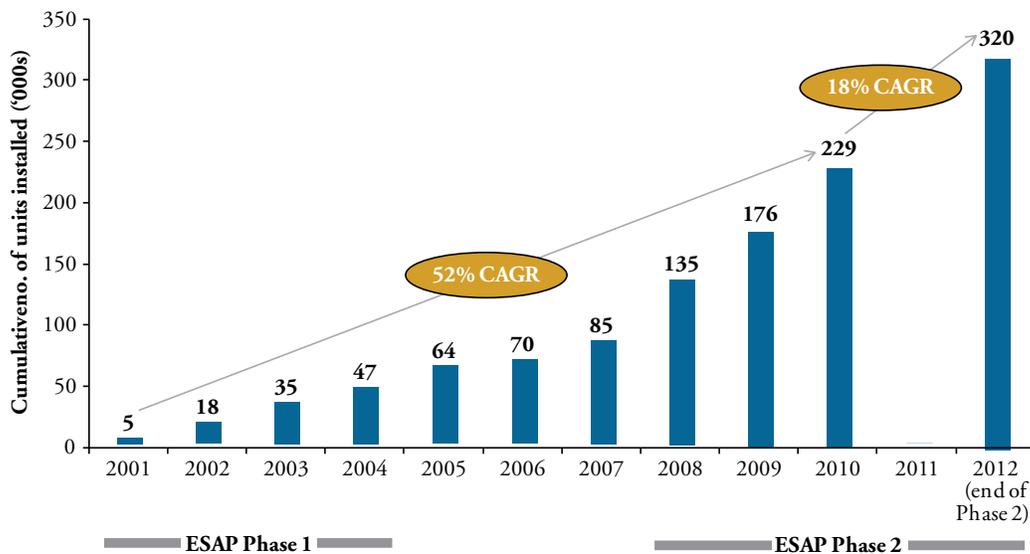
**Figure 4.3: Solar Tuki**

A Solar Tuki or a SSHS in Nepal is typically configured with a 3 Wp to 5 Wp solar panel, two LED lamps that use Nickel Metal Hydride rechargeable batteries. The lamp unit also has an outlet for connecting a FM/AM radio. Tukis are priced in the range of USD 50 to 70 and come with a one-year warranty.

Nepal’s market for solar lanterns is almost negligible. Discussions with business practitioners indicate that this is due to the lower warranty periods and the lack of battery availability for timely replacements. This is because the lanterns are primarily imported today. Moreover, the presence of affordable Solar Tukis in the market has led to a low demand for lanterns.

### Majority of the SHS installed in Nepal are through the AEPC program

The SHS market is heavily dependent on the government’s subsidy program. This program is overseen by the nodal organization for Renewable Energy promotion in the country, the Alternative Energy Promotion Centre (AEPC). It is estimated that SHS installations through the AEPC program constitute approximately 75-80% of the overall installations. AEPC has installed 229,000 SHS so far (Figure 4.4) at a CAGR of 52% since program inception, and is targeting another 90,000 systems by 2012. There has also been a sharp rise in the number of suppliers from 3 to 70 within the same timeframe.



Source: Primary research, Energy Sector Synopsis report (Government of Nepal), AEPC, The Tuki: Lighting Up Nepal, Intellecap analysis

ESAP=Energy Sector Assistance Program

**Figure 4.4: Cumulative number of SHS installed through AEPC subsidy program**

On a base of approx. 3 million off-grid households in Nepal, SHS installations of approx. 229,000 through AEPC suggest a penetration of approx. 8%. Considering that only 75-80% of the overall sales occur through the AEPC program, the overall penetration can be estimated to be a maximum of 10%.

### AEPC supports the solar off-grid lighting market through its SSP component

AEPC administers the Solar Energy Support Program (SSP) that is the nodal program for the promotion of solar off-grid lighting. The role of SSP entails setting the technical standards for SHS, qualifying the suppliers, approving the subsidies and monitoring the program implementation.

### Up to 60% of system cost covered by subsidy based on wattage and location

The higher the panel wattage and the more remote the location of the household, the higher the subsidy provided. Subsidies range from USD 67 to 134 depending on the remoteness of the location of the households as defined by AEPC, and the system wattage.

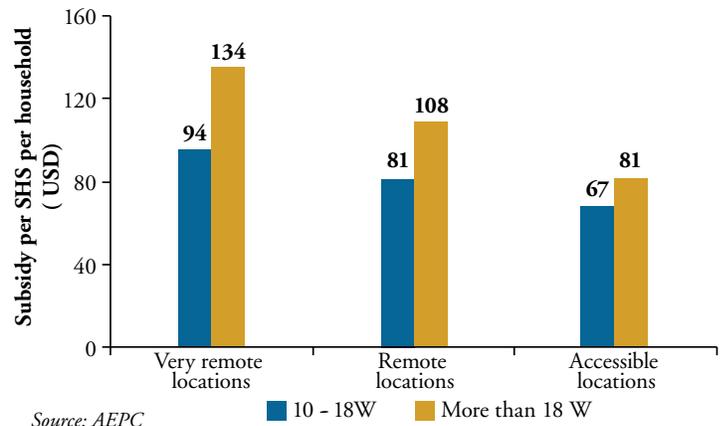
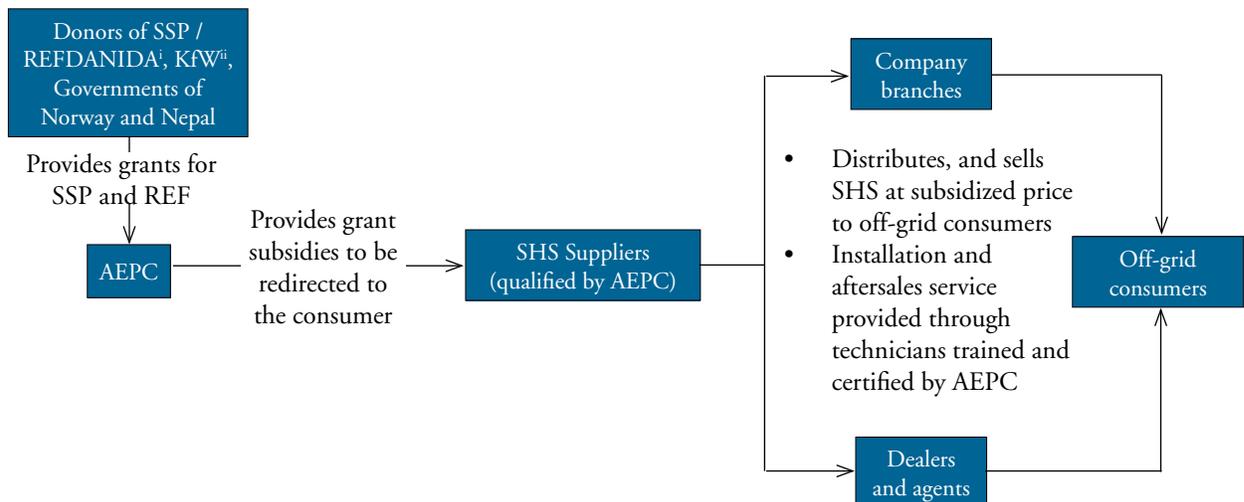


Figure 4.6: Subsidy structure of AEPC



i. DANIDA (Danish International Development Agency) is the funding agency of the Government of Denmark  
 ii. KfW is the funding agency of the Government of Germany  
 Source: AEPC Nepal, Renewable Energy Subsidy Policy and Subsidy Delivery Mechanism of Nepal, Primary research

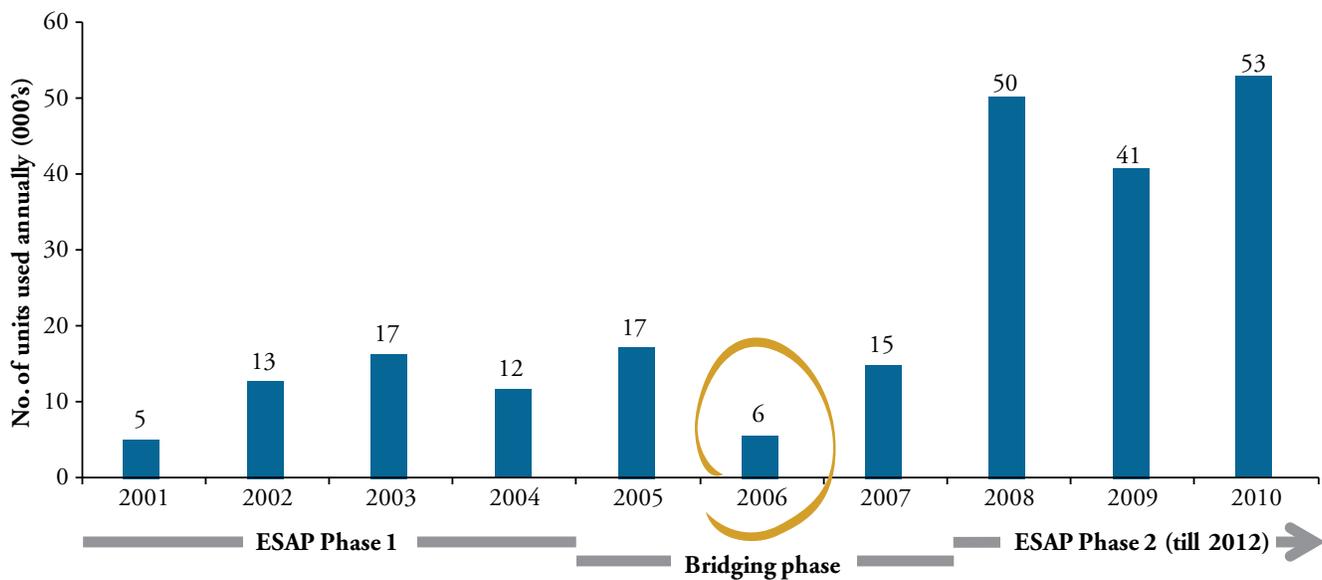
Figure 4.5: Schematic diagram of the AEPC subsidy program

### SHS sales are capped by the available subsidy funding

For a 20 Wp system priced at approximately USD 220, the subsidy is 30-60% of the price, depending on the remoteness of the location.

The total subsidy amount disbursed by AEPC up to September 2010 was in the range of USD 20-25 million.

SHS sales are heavily dependent on the subsidy provided by AEPC that in turn are capped by the funding provided by donors. This can be seen in Figure 4.7, where sales plunged in 2006 as subsidies were withdrawn temporarily due to donor funding being exhausted. Sales in 2008, however, recovered sharply as the subsidy program was renewed post-infusion with fresh funds from the donors.



Source: Primary research, Energy Sector Synopsis report (Government of Nepal), AEPC, Intellectap analysis

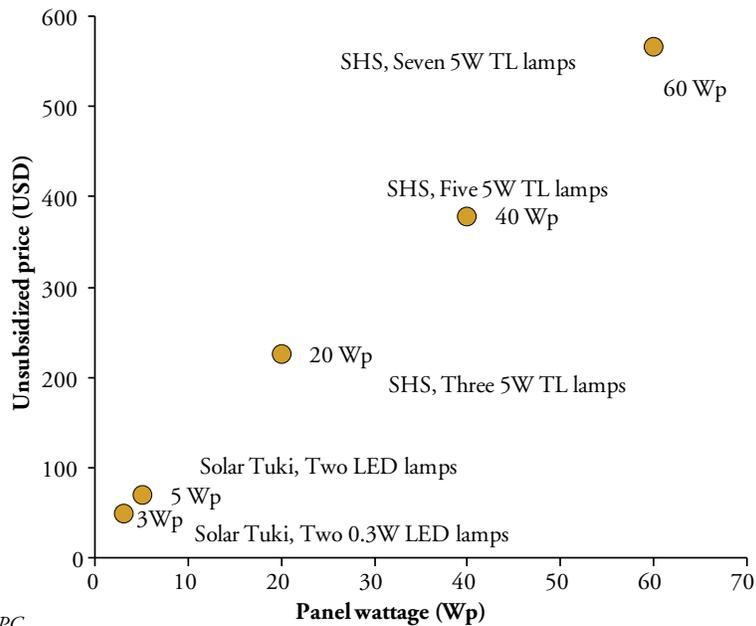
Figure 4.7: Annual SHS installations through AEPC

## 20 Wp SHS account for 80% of SHS sales

A 20 Wp solar home system, which can light three 5W tube lights, is the most dominant model sold in the market. This system is typically sold for USD 220 and is targeted at the low-income segment. Urban grid-connected households use higher wattage systems as a

power backup. Amongst them, 60 Wp systems are quite common and are sold at a price of USD 565.

In terms of technology aspects of product components, SHS in Nepal use LFL for products sold in rural areas.



Source: Primary research, AEPC

Figure 4.8: Mapping of product features and prices of SHS

However, systems sold in urban areas (higher wattage) are shifting towards CFLs. LFLs are manufactured locally while CFLs need to be imported. There is no evidence of LEDs being used. On the batteries, lead-acid batteries are predominant.

SHS are typically offered with a warranty of five years on battery and ten years on the panel.

## Solar Tukis have been recently included in the subsidy program

Solar Tukis have been included in the AEPC's subsidy program since 2008. The subsidy support is limited to Tukis that have a minimum capacity of 5 Wp with the subsidy amount being a uniform USD 27 across locations. As 5 Wp Tukis are priced around USD 70, the subsidy is approximately 40% of the cost.

The Centre for Renewable Energy (CRE), Global Environment Fund (GEF), the United Nations Development Program's (UNDP) Small Grants Program, Development Marketplace, Clean Energy Industry,

Home Employment Lighting Program are some of the organizations that have promoted Solar Tukis in Nepal.

The major objectives of these programs are to create awareness among the local community about solar off-grid lighting, to disseminate information on UNDP/GEF Small Grants Program, to provide microfinance to purchase Solar Tukis and to mobilize technical manpower at the local level.

### Despite low sales so far, Tukis have good market potential

There are an estimated 24,000 Solar Tukis installed in the country so far. Of this, 9,176 have been sold through the AEPC subsidy program (against a target of 300,000 Tukis from 2008 to 2012) and approximately 14,500 as a result of the donor group's efforts.

The reasons for the lackluster sales of the Tukis through the AEPC program are:

- 3 months waiting period for quality certification of Tukis by AEPC discourages many companies from introducing this product
- Higher demand for SHS in comparison to Tukis: Primary research indicates that many households in remote locations live in multiple room houses in Nepal, due to which the demand for SHS is higher

However, there are a significant number of households that would not be able to afford SHS even with subsidies and financing support. For such households, Tukis can be an effective lighting solution.

### In addition to subsidy provision, AEPC has adopted several measures to promote the market for quality solar off-grid lighting

- Ensuring product quality: All the companies supplying SHS (or Solar Tukis) through AEPC have to adhere to the Nepal Photovoltaic Quality

Assurance (NEPQA) standards. The standards are specified for all the product components such as solar panel, battery, lamps, charge controllers, mounting structure for panels, cables, switches, sockets and protections. The standards are divided into two types: mandatory and recommended.

- Companies interested in selling their products through the program have to get certified by AEPC to confirm that their components meet at least mandatory standards as tested by the Renewable Energy Test Station (RETS), which is the government mandated testing center. So far, 62 companies have been certified by AEPC to supply through the subsidy program. Affiliated to these qualified companies are more than 500 branches, offices, dealers and agents.
- Creation of skilled manpower: AEPC provides training for solar technicians who provide installation and after-sales service. Around 2,700 technicians have been trained and certified so far. These technicians have to be hired by the private sector companies for any installation or servicing activity.
- Close program monitoring: AEPC conducts field monitoring to verify the installation of SHS at the households. The suppliers are evaluated on different parameters such as quality of installation, performance of SHS, consumer satisfaction, price and financing of SHS, degree of consumer awareness of using the product well, after sales services and benefit to users from SHS.
- To ensure after-sales service, 10% of the subsidy amount is retained by the AEPC. Based on the supplier evaluation, the retained subsidy is deducted in proportion to the suppliers' deficiency in fulfilling the committed after-sales service. The evaluation also leads to grading of companies into three categories based on their performance. Based on these grades, companies are penalized (sometimes disqualified) for any non-compliance to the quality and after-sales commitments.
- Marketing and promotion: AEPC develops and disseminates various types of promotional material such as informational booklets on SHS, Tukis and the SSP. The SSP is also promoted on radio and TV.

### However, the program has challenges that need to be addressed

SHS targets are often achieved before time resulting in the market getting capped. For example, the SSP Phase 1 target was 40,000 SHS to be installed during the period 1999 to 2004. However, this target was achieved much earlier by 2002-03. Similarly, the target for 2010-11 was initially 50,000 SHS. Despite the AEPC extending it to 65,000 this has also fallen short of the demand. Therefore, it has now stopped accepting subsidy applications due to an exhaustion of funds.

In such a situation, it is difficult for companies to sell because consumers wait for the release of the next subsidy round. Also, the supplier faces risk of financial loss if the sales are made on expectations that the subsidy will be provided by AEPC and the subsidy window gets closed.

Three months wait time for approval of Solar Tukis: According to AEPC norms, the Tukis have to be certified to qualify for subsidy, which takes at least 3 months. This duration is in contrast to SHS, where the testing is done at a component level and monitoring is done on a sample, post installation. Solar Tuki importers / suppliers are discouraged with the 3 months wait time due to the risk of product rejection by AEPC. To compound this, their working capital gets tied up and there is a delay in their order-sales cycle.

Delay in the release of subsidies: Ideally, AEPC is supposed to release the subsidies to the manufacturers within 21 days of application from the companies. Due to the scarcity of funds, the process sometimes takes 2 to 3 months. The companies face working capital issues due to this delay.

### AEPC subsidy is likely to continue in the medium to long-term (5 to 10 years)

Currently, the market is extremely dependent on the subsidies and there is no established financing mechanism in place yet. AEPC believes that subsidy is essential for a few more years. There could be a change in the subsidy policy such as providing subsidies only in very remote locations. However, AEPC has not taken any final decision on this at the time of writing this report.

### Efforts are underway by AEPC to establish a consumer financing mechanism

In 2009, AEPC piloted a new model for credit financing of SHS called 'Credit Financing SHS - 2065.' Partner organizations for this project are Winrock International, SKBKS<sup>[48]</sup> and the National Cooperative Federation. The objectives of this pilot are two-fold:

- Enhance the capacity of selected Local Financial Institutions (LFIs) to provide loans for SHS installation
- Facilitate linkages between commercial/development banks, LFIs and solar companies

The pilot, launched in 6 districts, was successful, as banks provided wholesale loan to LFIs, which in turn financed consumers for purchasing SHS. In 2010, the number of districts was expanded to 14 and the number of LFIs offering loans increased to 43. The cumulative number of systems installed under the program so far is 3,500. The pilot is expected to run until September 2011.

The most encouraging aspect of this pilot is that even when the subsidy funds were depleted, some of the consumers started to purchase SHS on loans without the support of a subsidy. Though there were only 50 such consumers at the time of writing this document, this shows that the program if promoted and implemented effectively, could succeed in creating a market that is not subsidy-dependent.

Plans are to expand the pilot into a program covering all off-grid locations in Nepal with MFIs and rural banks also being included. With the Central Bank of Nepal issuing circulars to include lending to RE under priority sector lending, a further impetus to lending activity is being provided.

Ace Development Bank, a leading development bank in Nepal, is working with Winrock International, the Frankfurt School of Finance & Management and UNEP to expand the above mentioned pilot<sup>[49]</sup>.

[48] Sana Kisan Bikash Kendriya Sangh, an rural co-operative which is also a local financial institution (LFI)

[49] Source: [http://www.ace.com.np/?page=micro-finance&modee=Contents&cms\\_cd=69](http://www.ace.com.np/?page=micro-finance&modee=Contents&cms_cd=69)

### Solar component industry in Nepal is primarily import driven

Nearly all the major SHS components are imported. Solar panels are mostly imported from India and China. Batteries are imported from India, China and Bangladesh. LFL are manufactured locally, but CFLs are imported. Charge controllers are locally manufactured while lanterns and Tukis are imported.

### 4.3 Overview of regulatory environment

#### Scope for the regulators to shift focus from subsidy onto consumer financing

There is a strong focus of the AEPC on the promotion of solar off-grid lighting, mainly through subsidies and quality control. However, most manufacturers believe that the irregular and inadequate subsidy is proving to be more damaging than beneficial. They believe that attractive policies on consumer financing are more likely to enhance the market of solar off-grid lighting than subsidies.

Overview of regulatory environment- Nepal			
	Status	Impact on SHS	Impact on solar lanterns
<b>Subsidies – Solar lighting products</b>	<ul style="list-style-type: none"> <li>Offers up to 50% subsidy on the solar lighting product price</li> <li>Currently there is no established credit financing mechanism</li> </ul>	<ul style="list-style-type: none"> <li>Market is heavily dependent on the subsidies and irregularities in funding are impacting the scale</li> </ul>	<ul style="list-style-type: none"> <li>The inclusion of small wattage Solar Tukis in the program has provided an affordable option to low income households</li> </ul>
<b>Subsidies – conventional fuels</b>	<ul style="list-style-type: none"> <li>Currently there is no subsidy, however, there is a government proposal for providing a subsidy of - 0.13 USD per litre (up to 5 litres<sup>1</sup> every month) to people in off-grid areas. Students to get subsidy on 10 litres per month</li> </ul>	<ul style="list-style-type: none"> <li>Assuming that subsidy on Kerosene comes into effect, it is not too high to negatively impact SHS / solar lantern adoption</li> </ul>	
<b>Import tariffs and duties</b>	<ul style="list-style-type: none"> <li>No import duty on solar photovoltaic cells, modules/panels, LEDs</li> <li>1% duty on batteries</li> <li>10% ready-made solar lanterns</li> </ul>	<ul style="list-style-type: none"> <li>No import duties on PV modules and LEDs supports local assembly</li> <li>No import duty on Solar Tukis</li> </ul>	<ul style="list-style-type: none"> <li>Lanterns are currently imported and face duties</li> </ul>
<b>Taxation policies</b>	<ul style="list-style-type: none"> <li>VAT is free on components used in SHS and SSHS</li> </ul>	<ul style="list-style-type: none"> <li>Encourages manufacturers to set up more manufacturing assembly units</li> </ul>	

*Source: Literature review, Primary research*

#### 4.4 Nepal conclusion

Nepal has a sizable market potential of about 3 million households. Solar off-grid lighting products would be extremely cost competitive in this market given how expensive kerosene is in the country. There is already awareness in the market of off-grid lighting solutions and private sector enterprises could leverage and build on this.

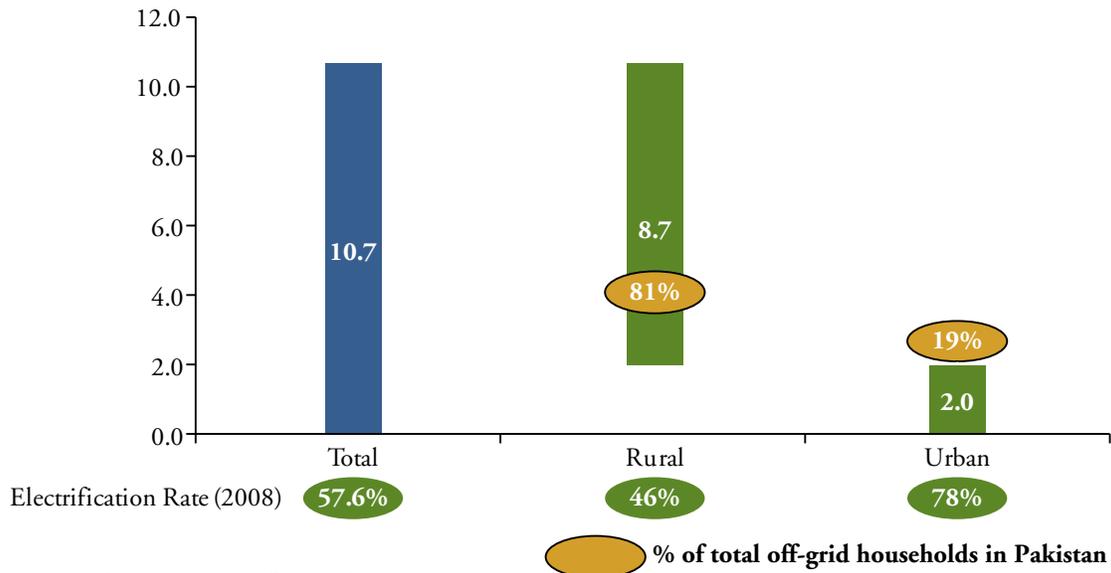
There are indications that the dependence on government subsidy is going to reduce in the future, as the consumer financing pilots by AEPC and Ace Development Bank are progressing well. The increasing focus on the promotion of more affordable Solar Tukis is likely to bolster affordability further.

Private sector companies have the potential to increase the effectiveness of these developments by increasing engagement with regulators, investors and other companies for promoting the market and reducing the dependence on subsidy-supported sales.

## 5. Pakistan Market Scoping

### 5.1 Current state of off-grid lighting

The total population of Pakistan is 197 million (or approximately 11 million households). Approximately 44% of the households are off-grid with 81% in rural areas.



Source: International Energy Agency, Intellecap analysis

Figure 5.1: Rural-urban distribution of off-grid households in Pakistan

A World Bank survey<sup>[50]</sup> indicates that 30-45% of rural households in Pakistan use kerosene as a primary or secondary source of lighting. The study also indicates that 80-90% of kerosene users in rural Pakistan are off-grid. As kerosene is not a major cooking fuel in Pakistan, it is safe to assume that this usage of kerosene is used to meet lighting needs.

Anecdotal evidence also suggests that in a few regions, candles are also an important source of lighting owing to the high price of kerosene.

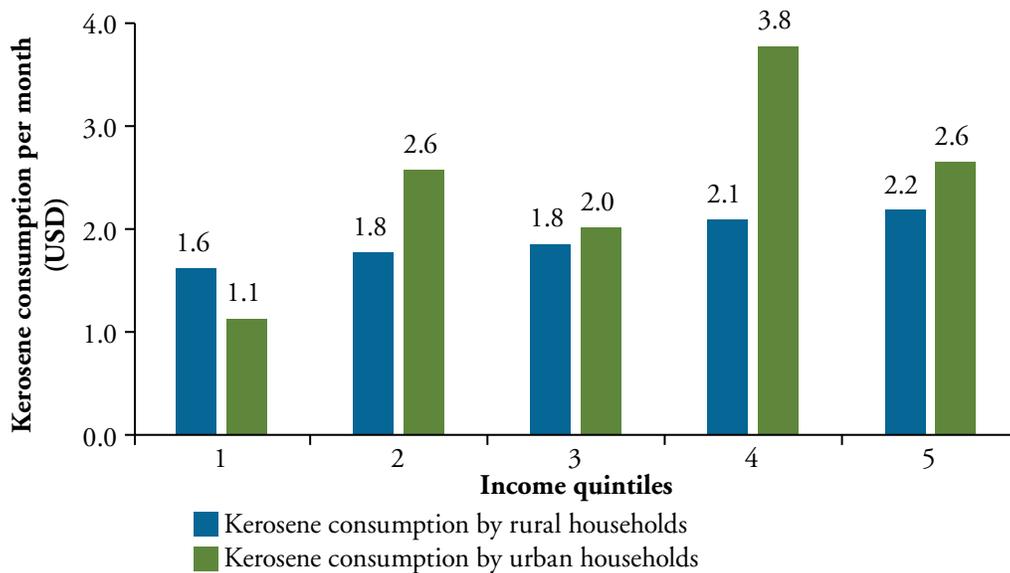
According to the survey, rural households consume approximately 2-3 liters of kerosene per month while



[50] Source: Changing Patterns of Household Expenditures on Energy, World Bank, 2009

urban households consume approximately 1-5 liters per month. As noted earlier, the majority of this is consumed for lighting. At the current price of USD 0.8 per liter of kerosene, this suggests a monthly expenditure of USD 1.5-2 (around 2% of rural

household expenditure<sup>[51]</sup>) by rural households and USD 1-3.5 by urban households on kerosene for lighting. Assuming 40% of rural households and 11% of urban households<sup>[52]</sup> consume kerosene, which translates into an annual expenditure of approximately USD 200 million.



Source: *Changing Patterns of Household Expenditures on Energy, 2009* (World Bank), Survey conducted in 2004-05, Intelicap analysis

**Figure 5.2: Monthly household kerosene consumption value across income quintiles (2004-05)**

## 5.2 An overview of solar off-grid lighting market

### No government efforts to promote solar off-grid lighting market in Pakistan currently; past efforts have failed

Currently, there is no national level program by the government to promote SHSs or solar lanterns. This is despite the presence of the Alternate Energy Development Board (AEDB), a dedicated government agency tasked with the promotion of renewable energy in Pakistan.

In 2005, AEDB launched a pilot to distribute SHS in rural areas. The objective of the pilot was to distribute the systems for free and collect fees to provide after-sales service through a trained village representative. The pilot was implemented in three phases covering 68 villages. Depending on each household's need, the

[51] Based on the expenditure of lowest income quintile

[52] Based on data from World Bank; 40% of rural HHs is approx. 6.5 million and 11% of urban HHs is approx. 1 million

capacity of the systems varied from 40 Wp to 120 Wp. The monthly fees for 40 Wp, 80 Wp and 120 Wp systems were USD 1.2, 1.7 and 2.3 respectively. The pilot was to distribute approximately 15,000 SHS, but only 3,000 SHS were distributed. The pilot did not meet its goals for the following reasons:

- Lack of adequate funds
- Inadequate prior planning in the areas of after-sales service and fee collection mechanism
  - There was no ownership by the users and as a result, the systems were poorly maintained
  - The users did not pay the fees as expected and AEDB, due to its inexperience in collection and recovery; faced difficulties in the fee collection process
  - AEDB was also unable to ensure effective after-sales support
- Lack of autonomy to AEDB from the government is also understood to have impeded the implementation process

From the donor community, the activity on solar off-grid lighting has also been sporadic. For example, donors such as United Nations Industrial Development Organization (UNIDO), UNDP and Pakistan Poverty Alleviation Fund have been distributing solar lanterns as part of their rehabilitation initiatives in the country.

### **Very few solar companies are catering to the rural off-grid areas**

There are no reliable estimates available on the solar off-grid lighting market penetration. Primary research indicates that the market penetration in rural areas is nearly zero in comparison to the number of off-grid

and under-electrified households. Though there are some companies that are trying to sell lower wattage SHS (20 Wp to 50 Wp), the outreach has been minimal.

Most solar off-grid lighting companies are interested in working with institutional clients such as schools, telecom companies, military and housing projects, where large systems are installed. Another large customer segment is affluent households in urban areas, who use SHS as a backup.

Due to the limited number of companies addressing the commercial market there are only a few distribution models followed and sales depend on ad hoc customer demand. Some companies such as Pakistan Solar Power and Solarwell, with presence in the agriculture sector, look to leverage their existing distribution channels of agricultural equipment and fertilizers.

Suppliers have opined that favorable policy environment and coordinated industry building effort by the government and donor agencies would help them in development of supporting infrastructure and in building a distribution channel for off-grid rural areas.

### **Huge market potential for private sector activity in solar lanterns**

Primary research indicates that NGOs and donors at no cost or subsidized cost, as part of relief programs, have distributed most of the lanterns currently used by off-grid households. This has led to some market distortion. Based on our interactions with some business practitioners in Pakistan, there is no evidence of companies selling lanterns commercially to consumers today.

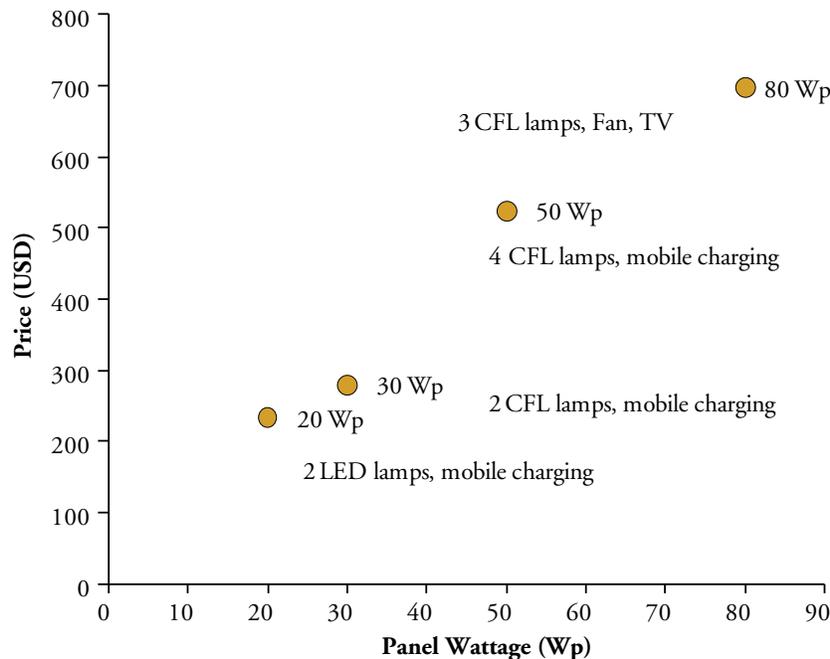
This implies that there is a huge untapped market potential for solar lanterns arising out of more than 10 million off-grid households and its cost-competitiveness against unsubsidized kerosene.

### Within the limited rural off-grid SHS market, 20 Wp and 50 Wp SHS sell the most

20 Wp and 50 Wp are the most commonly sold SHS in the rural areas. SHS price varies from USD 250 (for 20 Wp) to USD 700 (for 80 Wp). Comparison of different SHS is available in the market. (Figure 5.3)

In terms of technology used in the systems, lead acid batteries are dominant. CFLs and LEDs are equally used for lamps.

Some manufacturers provide a three-year warranty on maintenance batteries (that require regular maintenance by the consumer or after-sales service representatives) whereas some offer only one year warranty in case of maintenance-free batteries.



Source: Primary research, Intelicap analysis

Figure 5.3: Mapping of product features and prices of SHS

### Small-scale pilots are underway to provide consumer financing for SHS

The Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) is partnering with Tameer Bank, a microfinance bank in Pakistan, to launch a pilot for promoting SHS through provision of micro-credit. The pilot is expected to begin in 2011 in the Punjab region with targeted installation of 20,000 SHS in the first 2 years. Tameer Bank will leverage 100 of its existing customer touch points for this pilot.

Different products will be offered under the pilot, ranging from 30 Wp to 90 Wp. The target customer segment for a 30 Wp product would be households with a monthly income of approximately USD 45-70. The following credit terms would be offered to the consumer:

- Interest rate on the SHS loan would be at least 35% per annum
- Loan tenure of 3 years

- Approximately USD 35-45 (approximately 10% of the product price) would be down payment for a 30 Wp product

Tameer Bank plans to launch a company called Green Technology. This company will ensure the supply, sales and after-sales of service of the SHS.

The interesting aspect of this pilot is that the operating model is similar to that of the IDCOL program in Bangladesh to the extent that the supply and financing of SHS is undertaken by the same organization. The pilot is yet to be implemented and its effectiveness needs to be seen. The success of the pilot will enable organizations such as Tameer Bank to invest in this market more aggressively, and more importantly, it will create a demonstration effect in Pakistan.

### SHS components are entirely imported, but SHS are assembled in Pakistan

Manufacturers rely on imports for the product components and assemble SHS locally. The solar panels are primarily imported from Japan, China and Germany whereas LEDs are imported from China. While batteries

are both imported (from China) and locally procured, some importers have expressed concerns on the quality of the locally made batteries and therefore prefer to have them imported.

### 5.3 Overview of regulatory environment

#### There is a need for favorable policy environment; reduction of import duties on PV panels is a priority

No subsidy on kerosene, no import duty on some key components and VAT exemption on SHS components are among the progressive policies in Pakistan that are helping the sector. Primary research indicates that though AEDB has recommended the waiver of import duties, the customs department in the country continues to levy 30-35% import duties on PV panels and 15% on assembled SHS and solar lanterns.

The lack of political stability has also been thwarting the prospects of private investments into the country in general, and by extension, the solar off-grid lighting industry as well.

Overview of regulatory environment- Pakistan			
	Status	Impact on SHS	Impact on solar lanterns
Subsidies – conventional fuels	<ul style="list-style-type: none"> <li>• No subsidy is offered on Kerosene</li> </ul>	<ul style="list-style-type: none"> <li>• High kerosene prices offer an opportunity for consumers to evaluate alternative options such as solar for lighting</li> </ul>	
Import tariffs and duties	<ul style="list-style-type: none"> <li>• 32% import duty levied on solar photovoltaic cells modules/panels</li> <li>• 0% on LEDs</li> <li>• 10% duty on batteries</li> <li>• 15% ready-made solar lanterns</li> </ul>	<ul style="list-style-type: none"> <li>• Import duties on PV modules increases the cost of overall SHS or a lantern and raises the affordability barrier. There is an opportunity to decrease the panel cost by 20% if the import duties are not levied on solar panels</li> </ul>	
Taxation policies	<ul style="list-style-type: none"> <li>• VAT is free on components used in SHS</li> <li>• General Sales Tax of 17% is applicable</li> </ul>	<ul style="list-style-type: none"> <li>• Though SHS suppliers are exempt from VAT, they need to pay General Sales Tax of 17%, which the suppliers consider very high</li> </ul>	

Source: Literature review, Primary research

#### 5.4 Pakistan conclusion

Despite its nascent market, Pakistan holds a promising market given its large off-grid population. The high kerosene prices mean that kerosene usage for lighting is an expensive proposition for the rural and low-income off-grid households. Therefore, the cost-effectiveness of solar lighting would be far higher in Pakistan compared to other countries where kerosene is heavily subsidized.

The emergence of industry associations such as the Renewable and Alternative Energy Association of Pakistan and new ventures such as Tameer Bank's consumer financing pilot are an indication that private sector activity in the market has potential.

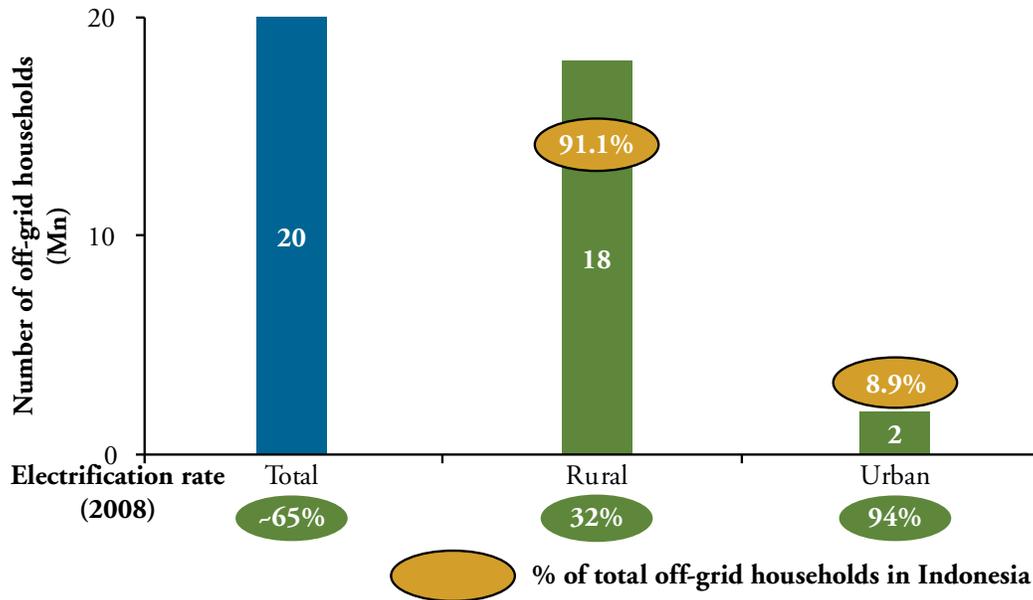
Private sector enterprises need to create and spread consumer awareness widely about solar lighting products in rural areas to drive demand for such products. They must also vigorously engage with policymakers to reduce or remove import duties on PV panels and solar lanterns. An industry association should work closely with the government for a favorable regulatory environment to support the growth of the solar off-grid lighting industry.

## 6. Indonesia Market Scoping

### 6.1 Current state of off-grid lighting

Indonesia is a large archipelago of islands with a total population of approximately 231 million people (or 57 million households<sup>[53]</sup>). Of this, an estimated 35%

or 20 million households are currently off-grid. 91% of these households are located in rural areas and remote islands such as Nusa, Maluku, and Papua.<sup>[54]</sup> In these areas, the electrification rate is just 32%.



Source: International Energy Agency, Intellecap analysis

Figure 6.1: Rural-urban distribution of off-grid households in Indonesia

[53] Source: International Energy Agency

[54] The electrification rates on remote islands such as the islands of Nusa, Maluku, and Papua are very low ranging from 20 to 50%

### Remote areas unlikely to be on-grid in the near future due to unviable economics

As per government estimates<sup>[55]</sup>, 40% of the off-grid villages today, largely located outside of Java, are unlikely to be reached by the national electrification grid owing to their remoteness and the scattered population.<sup>[56]</sup> Though there have been efforts to provide electricity through diesel genset mini-grids, due to the nation-wide uniform electricity tariff applied by the government, these mini-grids have incurred losses and discouraged private sector participation. Under these circumstances, the solar off-grid lighting systems such as lanterns and SHS are an appropriate solution.

### Kerosene, heavily subsidized in Indonesia, is a major source for lighting in off-grid areas; over USD 0.5 billion is spent on kerosene for lighting annually

Kerosene is heavily subsidized and is available for approximately USD 0.27 per liter.

A 2005 survey by the World Bank estimates that approximately 80-90% of the rural and urban households across income quintiles consume kerosene. Furthermore, the study found the monthly consumption of kerosene for lighting varies from 2-5 liters in rural and 4-6 liters in urban households<sup>[57]</sup>.

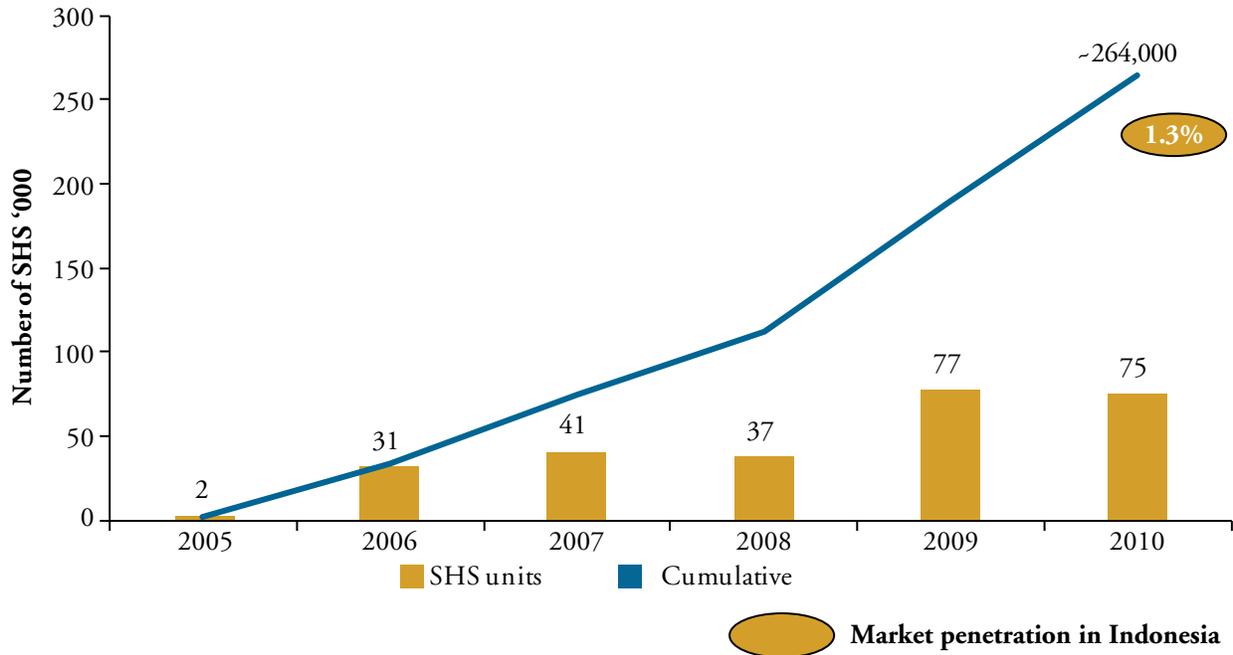
The total expenditure on kerosene by off-grid and under-electrified households for lighting is estimated at approximately USD 0.56 billion<sup>[58]</sup>. This translates to around 2% (USD 1 per household) of the monthly rural household expenditure.

[55] Source: Perusahaan Listrik Negara (PLN), the largest energy provider in the country

[56] Source: Indonesia Energy Assessment. USAID, November 2008

[57] Source: Changing Patterns of Household Expenditures on Energy, World Bank, 2009

[58] Calculated as total kerosene consumption of 8.18 billion liters, 25% of which is used for lighting. Current kerosene price stands at approximately USD 0.27 leading to total expenditure of approximately USD 0.56 billion on kerosene by off-grid households



Note: 2010 number is based on estimates. Primary research indicated 50,000-100,000 SHS installed

Source: Primary research, AFEEC – FAPECA meeting, Kuala Lumpur

Figure 6.2: Number of SHS installed through the government tender scheme

## 6.2 An overview of solar off-grid lighting market

### SHS market is driven by the government's rural electrification program

Under the rural electrification program, the government procures SHS from local companies and provides them to a limited number of households for free. The Laboratorium Sumber Daya Energi (LSDE)<sup>[59]</sup>, a government body, accredits the products procured through tenders/bids, while the suppliers are responsible for installation and training of the local technicians to ensure after-sales services. The costs for providing these services are included in the cost quoted to the government

tenders. The most common product distributed is the 50 Wp SHS with a 6W fluorescent lamp and a 70 Ah lead acid battery.

An estimated 260,000 SHS have been installed under the government scheme, constituting a market penetration of only 1.3%.

The government program faces many issues, mainly arising out of the lack of ownership by beneficiaries, the lack of after-sales service and maintenance and inadequate monitoring and evaluation by the implementing agencies.

[59] A governmental organization engaged in the field of energy to assist the government in national development

### Commercial models for SHS are emerging outside the government program

Most of the solar off-grid lighting companies targeting the BOP segment sell SHS through the government tender process and other donor programs. Other companies target the more affluent urban classes and institutional clients with some stating that they would not go into rural areas because of the government program and the market distortions created by it.

However, a few companies are trying to reach out to rural customers in a commercial way. One example is of a major importer of solar panels that has 95% of its SHS sales through the government program. It now aims to pilot commercial sales of a 20 Wp product (priced at approximately USD 220) and build a network of technicians to overcome servicing and maintenance issues.

### No established market for solar lanterns yet

Currently, the government program does not include solar lanterns, and in Intellecap research, we have not come across any private sector or donor-led initiative that is promoting solar lanterns. Industry experts point to a significant presence of a black market for solar lanterns leading to quality concerns, and indicate that there is an opportunity for enterprises with good quality lanterns to enter the market.

### Upcoming programs hold promise to commercialize SHS and lantern market

There have been some significant donor-backed efforts to promote solar off-grid lighting that have not succeeded. Some new efforts are being tried that hold promise:

**UNEP payroll deduction program:** This scheme is mainly targeted at palm oil farmers as they often have a stable and regular income. Under this program, solar

off-grid lighting companies would partner with large agri-based companies, who would deliver products to farmers and deduct payments from the crop payments made to them. SHS dealers such as PT Mambruk Energy International and Shell Solar Indonesia have already demonstrated retail sales amongst palm oil farmers.

**TERI solar multi utility (SMU) program:** TERI has partnered with PT Azet has piloted a program based on the LaBL rental program in India and currently has three installations in Bandung province. The program seeks to leverage the large number of solar panels lying idle in the country as a result of failed government programs. By leveraging this infrastructure, each of the SMUs would generate electricity to charge approximately 10 lanterns and provide lighting to 10 households.

Each of the SMUs would be managed by a local entrepreneur who would receive a daily rental fee for renting out lanterns (currently USD 0.10-0.15/lantern/day) and would also provide after-sales services. TERI believes that there is potential to setup 200,000 SMUs in the country at a cost of USD 90 million (Cost/SMU is USD 450). TERI believes that this model will address the issue of inefficient after-sale services today and mobilize local banks to provide financing to companies and entrepreneurs<sup>[60]</sup>.

### PV panel market in Indonesia is completely import driven

With the exception of one company, PT Len, that produces PV modules locally, almost entire demand for PV modules is imported. Batteries, charge controllers and DC lamps are however produced locally.

[60] Source: Scoping Mission Report – Indonesia under Solar Lantern Working Group, TERI, March 2010

### Solar lending to end-consumers nearly non-existent despite a strong MFI sector

The microfinance sector in Indonesia possesses a strong infrastructure and expertise in urban and semi-urban areas. However, its reach in rural areas is low, limiting the ability to extend credit to off-grid households in remote areas of the country. MFIs in Indonesia collateral with land records being the most commonly used instrument. Solar off-grid lighting products are not accepted as collateral<sup>[61]</sup>.

A past pilot project by Bank Rakyat Indonesia (BRI), a leading MFI, Shell Solar and PT Mambruk International faced issues due to low consumer densities in rural areas leading to distribution, after-sales and payment collection challenges. In addition to this, customers perceived the down payment as too high and moreover, market distortion by free distribution by the government led to the initiative's failure.

### 6.3 Overview of regulatory environment

#### Subsidized kerosene and free SHS distribution are the biggest regulatory hurdles

Following is a snapshot of the regulatory issues impacting solar off-grid lighting in Indonesia.

Overview of regulatory environment- Indonesia			
	Status	Impact on SHS	Impact on solar lanterns
<b>Financing support – Solar lighting products</b>	<ul style="list-style-type: none"> <li>Free dissemination of Solar Home Systems to end-consumers as part of the rural electrification program</li> </ul>	<ul style="list-style-type: none"> <li>Leading to market distortions, inhibiting engagement of private sector players to grow market</li> </ul>	<ul style="list-style-type: none"> <li>Government tenders do not include solar lanterns</li> </ul>
<b>Subsidies – conventional fuels</b>	<ul style="list-style-type: none"> <li>Kerosene is heavily subsidized and is available at USD 0.27 per liter (subsidized)</li> </ul>	<ul style="list-style-type: none"> <li>The subsidized kerosene price makes solar lanterns and solar home systems less competitive</li> </ul>	
<b>Import tariffs and duties/ Taxation policies</b>	<ul style="list-style-type: none"> <li>No import duties on solar panels</li> <li>Duties of 5-10% on solar lanterns</li> <li>Duties of 5-10% on charge controllers</li> <li>VAT 10%</li> </ul>	<ul style="list-style-type: none"> <li>No import duty on solar panels encourages local assembly</li> </ul>	<ul style="list-style-type: none"> <li>Lanterns are imported; market is too small</li> </ul>

[61] Source: Reinforcing provision of Energy Services in Bangladesh and Indonesia for Poverty Alleviation and Sustainable Development, RENDEV and IT Power

#### 6.4 Indonesia conclusion

With over 20 million off-grid households, Indonesia offers the second largest market potential for solar off-grid lighting products in Asia after India. The government has been attempting to address the lighting need by distributing SHS freely, but it has managed to cover mere 1.3% of the off-grid households.

The need and opportunity for private sector intervention is clear. The favorable import duty allows companies to manufacture the products affordably. Commercial models such as PTBBM and the UNEP payroll deduction program are pioneering efforts to provide solar lighting in rural Indonesia. Private sector enterprises entering Indonesia should look to leverage the strong MFI presence to reach out to the masses and scale up rapidly.

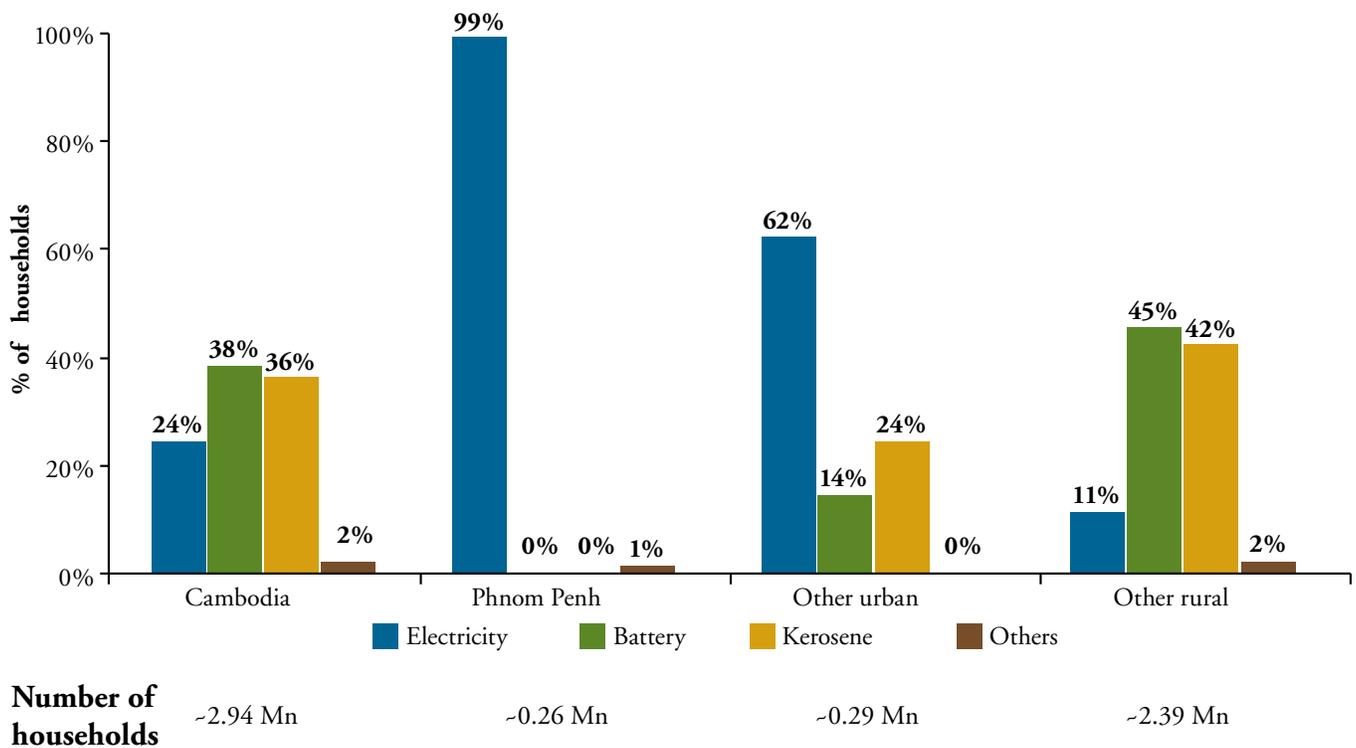
## 7. Cambodia Market Scoping

### 7.1 Current state of off-grid lighting

**Cambodia has a low electrification rate of 24%; kerosene and batteries are the dominant lighting sources in off-grid areas**

Cambodia has a population of approximately 15 million people (or 2.9 million households) and has the lowest electrification rate amongst the countries in this report, at just 24%. Cambodian households have very limited access to electricity and clean energy with the majority depending on kerosene and batteries for lighting.

Under the Master Plan for Rural Electrification, the Government plans to electrify approximately 872,000 households in approximately 14,000 villages by 2020. However, this would cover less than 40% of the off-grid households in Cambodia today, estimated at 2.2 million households.



Note: 1. Electricity includes on-grid public and private generated electricity 2. Other includes candle, etc.

Source: Housing Conditions 2007 (NIS), Intelicap analysis

**Figure 7.1: Distribution of households by primary source of lighting (2007)**



*Image courtesy of Yejj Solar/Barefoot Power (Photo D Pacheo)*

## Kerosene and batteries are the key off-grid lighting sources

An estimated 1.06 million households in Cambodia are believed to be using kerosene as their primary source for lighting while 1.12 million households are using batteries as their primary source for lighting (Figure 7.1). The high percentage of households relying on car batteries is unique to Cambodia, when compared to the other six countries analyzed in this report.

A survey conducted by UNDP Cambodia in 2006 shows that households are using a combination of kerosene and batteries for lighting. Also, income levels are directly linked to the households' ability to use either or both kerosene and batteries. For lighting, poorer households predominantly use only kerosene, whereas higher income households with higher energy needs, use batteries.

## USD 112 million is spent annually on off-grid lighting

With 90%<sup>[62]</sup> of kerosene consumed by households for lighting, at the current price of approximately USD 0.74 per liter, an estimated USD 60 million is spent on kerosene for lighting. This leads to an average household monthly expenditure of approximately USD 2.7 (approximately 4.9% of rural household expenditure<sup>[63]</sup>) or consumption of approximately 3.6 liters per month.<sup>[64]</sup>

After kerosene, second most dominant sources of energy in rural Cambodia are battery banks. In general, 50 ampere-hour (Ah) battery is used for home lighting, 70 Ah for lighting and TV, and 100 Ah for also running video players.

Over 13,000 villages in Cambodia are covered by battery charging stations (BCS). These BCS are run on diesel generators and are operated by local



Battery Bank in Cambodia Image courtesy of Kamworks

entrepreneurs, charging approximately 90-100 cents/Kwh, which is over five times the cost of electricity supplied through the national grid<sup>[65]</sup>. These BCS also create a heavy environmental impact, producing an estimated 153,337 tons of CO<sub>2</sub> annually<sup>[66]</sup>.

Consumers spend approximately USD 2.5 per month (approximately 4.5% of rural household expenditure) to charge the battery for about five times. While 1.12 million households are using batteries as their primary source of lighting, an additional 0.62 million households<sup>[67]</sup> are estimated to use batteries as a secondary source of lighting, when the primary source is pre-dominantly grid or mini-grids. This leads to an estimated annual expenditure of over USD 52 million on battery charging.

[62] Residential energy demand in rural Cambodia; Source: UNDP Cambodia

[63] Based on the expenditure of lowest income quintile

[64] Calculated as USD 60 million spent per annum on kerosene divided by the total of 69% of rural households (approximately 2.5 million) and 24% of urban households (approximately 441,000)

[65] Tariff set by Electricité du Cambodge (EDC) varies from USD 9 to USD 23 cents/kWh

[66] Based on: [http://sgp.undp.org/web/projects/12855/solar\\_battery\\_charging\\_project.html](http://sgp.undp.org/web/projects/12855/solar_battery_charging_project.html)

[67] Approximately 73 % rural HHs and 6% of urban HHs are using Battery based on survey of 2,000 HHs conducted in Svay Rieng and Kampong Speu by UNDP

## 7.2 An overview of solar off-grid lighting market

### The market for modern off-grid lighting in Cambodia is nascent...

Companies such as Khmer Solar, Solar Energy Cambodia and Comin Khmere mainly supply SHSs catering to middle-higher income segments, institutions and to donor programs. Only a handful, such as Kamworks and Yejj Solar, are directly targeting the BOP with innovative products and distribution models. The main challenges they face are the lack of efficient distribution channels and lack of access to finance.

Primary research indicates that only approximately 10,000-20,000 SHSs and less than 10,000 solar lanterns have been installed in Cambodia so far. Based on estimates, the penetration rate of solar off-grid lighting products in Cambodia is extremely low, standing at 1-1.5%.

Due to this low market penetration and issues in technical competence, availability of skilled staff and investment issues, there is minimal local manufacturing capacity in Cambodia. Product components are primarily imported and then assembled locally. In the case of solar lanterns, they are almost entirely imported. Kamworks is the sole company that assembles its lanterns locally.

### ...and a large presence of sub-standard products

Interviews with major stakeholders indicate that the majority of SHS and solar lanterns sold in the market today are sub-standard, often smuggled in from China. Primary research indicates that the presence of sub-standard products is as high as 50% for the SHS market and even higher for solar lanterns.

This is leading to a major loss of trust among the rural population about the benefits of solar off-grid lighting and is resulting in market spoilage. Currently, there is no agency regulating quality issues of solar off-grid lighting products or certifying imported products.

### 40 Wp and 80 Wp SHS are the most popular SHSs available targeting the rural affluent and rural rich

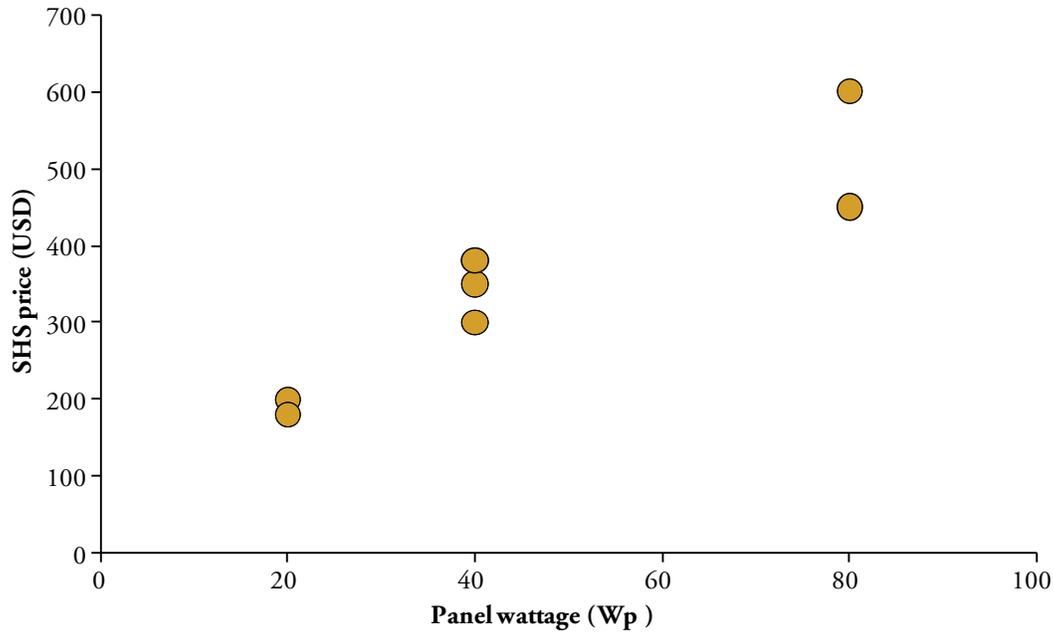
The retail price of SHS in Cambodia ranges between USD 7-9 per Wp.

As shown in the Figure 7.2, solar lighting companies are targeting the rural affluent and rural rich households earning an annual income of above USD 1,100. The very poor and poor households are currently not a target segment for the SHS.

### Solar lanterns from professional companies are available for USD 15 to 25

While the majority of the lanterns available in the market are of poor quality and smuggled into the country, two major organized enterprises focusing on low-income segments are Yejj Solar, which imports Barefoot Power products for distribution, and the locally assembled MoonLight lantern by Kamworks.

Most products are sold for cash; however, Yejj and Kamworks are piloting rental and MFI partnership models to provide energy access to households that cannot afford the upfront cost of the product.



Source: Primary research, Intellectap analysis

Figure 7.2: Retail price of SHS available in Cambodia

### Private enterprises have piloted various market-building approaches

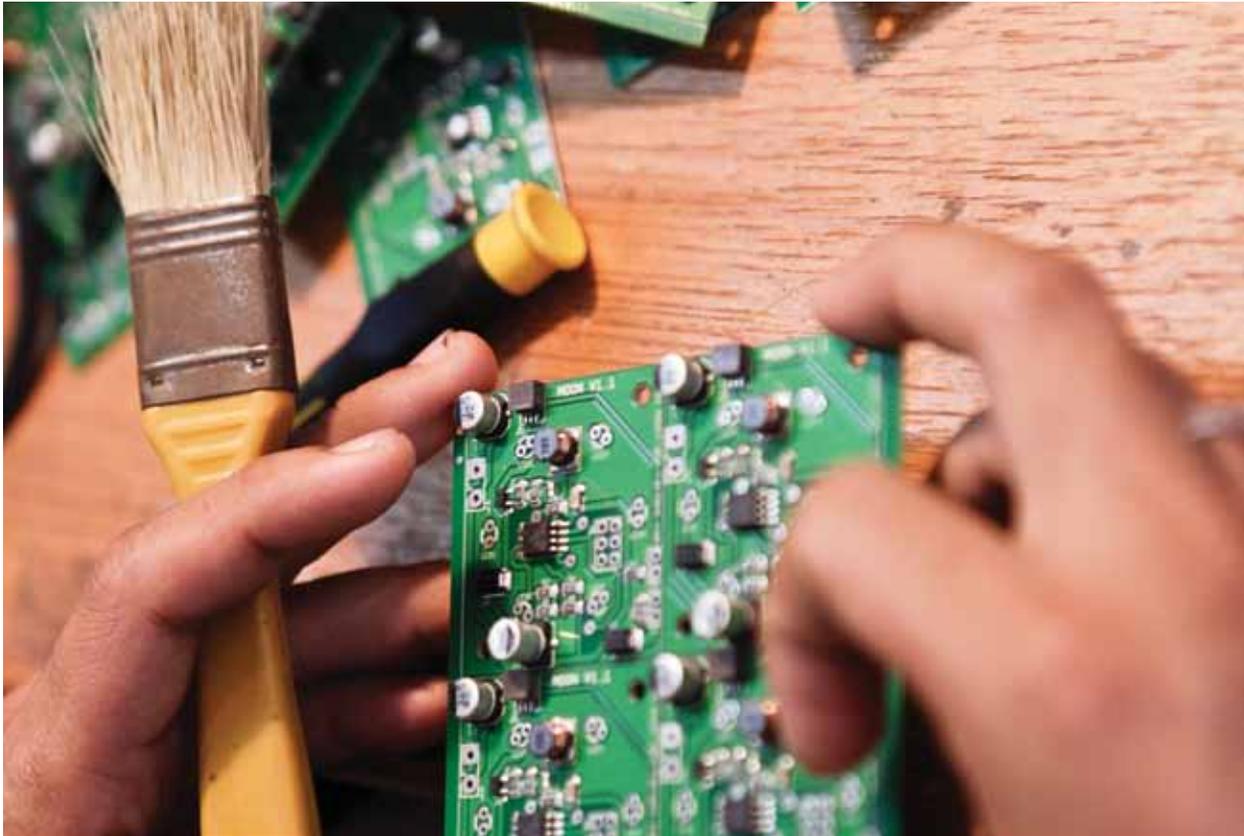
Most initiatives by private enterprises to address issues such as financing, consumer awareness, and accessibility are currently in the research and pilot stages. Kamworks is at the forefront of piloting various market approaches in Cambodia to increase its outreach to low-income segments.

### On Consumer Financing:

Yejj Solar partnership with Vision Fund Yejj is partnering with Vision Fund, an MFI, to offer access to finance for both end consumers and rural entrepreneurs willing to act as agents of SHS products it sells. Further, there is ACLEDA Bank and Local Capacity Builder (LOCAB)<sup>[68]</sup> partnership. With over 230 branches across the country of which approximately 75% are located in rural areas, ACLEDA Bank has recently entered into a Memorandum of Understanding (MOU) with the NGO LOCAB. LOCAB would provide technical expertise and after-sales maintenance of the systems while ACLEDA would provide the financing<sup>[69]</sup>.

[68] Local Capacity Builder (LOCAB) is a non profit organization founded in 1997 that works on the promotion of solar technologies in the country

[69] Primary research



*Image courtesy of Kamworks (Mathieu Young)*

Rental models: These are also being tested where rural entrepreneurs are renting out lanterns on a daily basis, recharging these lanterns with solar or diesel powered charging stations as detailed below.

#### **On Creating Consumer Awareness:**

To address the consumer awareness issue Yejj Solar, selects NGOs with a track record of at least five years to provide training to the local entrepreneurs, who then sell lanterns to their communities.

Kamworks implements various marketing initiatives such as educational games and school campaigns to improve consumer awareness. It also has a sales team of approximately 25 people who engage with the village chiefs and pitch to wealthier households in each village.

#### **On Improving Accessibility and Servicing:**

Kamworks partnered with PicoSol in setting up a training facility – “The Solar Campus”. The facility provides trainings on solar energy. Kamworks also offers a discount of USD 15 on its SHSs if the customer participates in a training course.

#### **On SME Financing:**

The lack of SME financing is one of the major barriers in Cambodia. Normally solar off-grid lighting companies have to pay 18-20% in interest rate and also have to deal with high collateral requirements (up to approx. 200% of the loan amount). The solar components and products are not accepted as collateral.

## **Kamworks case study**

### **MoonLight rental scheme**

Kamworks, a solar off-grid lighting start-up, is experimenting with a MoonLight rental scheme since 2009, whereby village entrepreneurs are renting out solar lanterns at rates matching daily kerosene expenditure. So far, approximately 130 lights have been provided through three locations. Kamworks is collaborating with Pico Sol in a project called Enabling Access to Sustainable Energy (EASE) supported by ADB's Energy for All program, which aims at scaling up the MoonLight village entrepreneur rental scheme.

Solar Guarantee Fund: Kamworks and Pico Sol (an NGO) are currently developing a solar guarantee fund for solar lantern entrepreneurs thereby facilitating access to finance for them.

Financing solar off-grid lighting entrepreneurs: Amret Microfinance and ACLEDA Bank are financing entrepreneurs in setting up BCS. Between them, they have financed over 400 entrepreneurs operating these stations. While these banks have also financed solar SMEs, the scale of financing is unknown.

### **Rural Electrification Fund (REF) is the key donor program in the country**

The World Bank, under its Energy Sector Management Assistance Program (ESMAP), formulated the Rural Electrification Fund in 2004 to electrify 12,000 households with SHS. As part of its design, the Fund was to provide financial assistance for the installation of 12,000 SHS with the support of a USD 100 grant per SHS of a minimum capacity of 40 Wp.

Despite the grant facility, the program did not achieve its intended target; only approx. 95 SHS were



*Image courtesy of Yejj Solar/Barefoot Power (Photo D Pacheo)*



*Image courtesy of Kamworks (Mathieu Young)*

distributed through this facility. Lack of credit financing for the consumer was the key reason for its failure as it was difficult for most rural households to afford a USD 400 SHS even with a USD 100 subsidy.

To address the issues with the program design, the program has recently been restructured. Under its new design, the Fund will procure 12,000 SHS (approx. 90%

of 50 Wp and approx. 10% of 30 Wp) in bulk from a private sector company that will also be responsible for installing them. The households will be selected from areas that are not likely to be connected to the wider grid in the next 3 to 5 years. They will have the choice to pay in full upfront or in interest free installments over a period of maximum five years and are also entitled to the original USD 100 subsidy under the program.



*Image courtesy of Yejj Solar/Barefoot Power (Photo D Pacheo)*

Additionally, the REF will also select an organization responsible for marketing the Rural Electrification Fund program and creating greater awareness on the benefits of solar off-grid lighting among the rural population. Further, a third-party private company will be responsible

for the supervision and maintenance of the SHS (post warranty period) as well as payment collection of the monthly installments. The Fund is designed to be a revolving fund, whereby the collected payments are used for procurement of additional systems at a later stage.

### 7.3 Overview of the regulatory environment

#### High import duties and taxes are the biggest regulatory hurdles for the industry

High duties on components (35%) and favorable import duties (7%) for solar lanterns discourage companies from assembling products locally and promote the import of completed products.

In addition to high duties on electronic components, the cost of doing business in Cambodia is a heavy burden for smaller local companies. Primary research indicates that companies have to pay high fees for procuring customs and clearance documents, further increasing the end consumer price of solar off-grid lighting products. To

obtain special tax cuts, SHS providers would need to have a minimum investment of USD 1 million, which only a very small number of companies have today.

To counter these issues, select companies in the country are contemplating setting up an Association of Solar Off-grid Lighting Companies to lobby with the government on policies and address major issues including lack of awareness and market spoilage with sub-standard products smuggled into the country.

Overview of regulatory environment- Cambodia			
	Status	Impact on SHS	Impact on solar lanterns
<b>Financing support – Solar lighting products</b>	<ul style="list-style-type: none"> <li>REF has been set up however has not yet disbursed subsidies on SHS</li> </ul>	<ul style="list-style-type: none"> <li>Impact of the REF is yet to be seen</li> </ul>	<ul style="list-style-type: none"> <li>No financing support for lanterns</li> </ul>
<b>Subsidies – conventional fuels</b>	<ul style="list-style-type: none"> <li>Current price of kerosene is USD 0.74 per litre; subsidies are not available</li> </ul>	<ul style="list-style-type: none"> <li>Kerosene price is not subsidized making the usage of solar lanterns and solar home systems more competitive</li> </ul>	
<b>Import tariffs and duties</b>	<ul style="list-style-type: none"> <li>The import duties on solar panels have been recently brought down, however, there is still scope for further reduction. Other duties include 15% for batteries, 15% for plastic, 35% for electronics</li> <li>7% duty on solar lanterns</li> </ul>	<ul style="list-style-type: none"> <li>7% import duty on solar panels, need for a further reduction in rates</li> <li>Difficult to prove that LEDs, are components of SHS and don't fall under "electronics" duties</li> </ul>	<ul style="list-style-type: none"> <li>7% duty on solar lanterns</li> <li>High import duties for finished products</li> <li>Difficult to prove that LEDs, are components of SHS and don't fall under "electronics" duties</li> </ul>
<b>Taxation policies</b>	<ul style="list-style-type: none"> <li>10% Value Added Tax</li> <li>High taxes and cost of doing business (-USD 200-500 for customs and clearance document)</li> </ul>	<ul style="list-style-type: none"> <li>To obtain special tax cuts for SHS providers, a company has to have a min. investment of USD 1 Mn to fall under this category</li> </ul>	

Source: USDAID SME Development Framework, Primary research. Customs Department of Cambodia

#### 7.4 Cambodia conclusion

Cambodia holds significant potential for solar off-grid lighting with an electrification rate that is merely 24%, lowest among the seven focus countries. Despite the government's aggressive rural electrification plans, it is estimated that about 50% of the households will still remain off-grid by 2020.

Most of the off-grid households use either batteries or kerosene for lighting today. The off-grid households, on average, spend more than USD 30 per annum on these sources for lighting. There are companies selling solar lanterns priced at USD 15-25 aiming to displace the kerosene and battery based lighting with solar off-grid lighting.

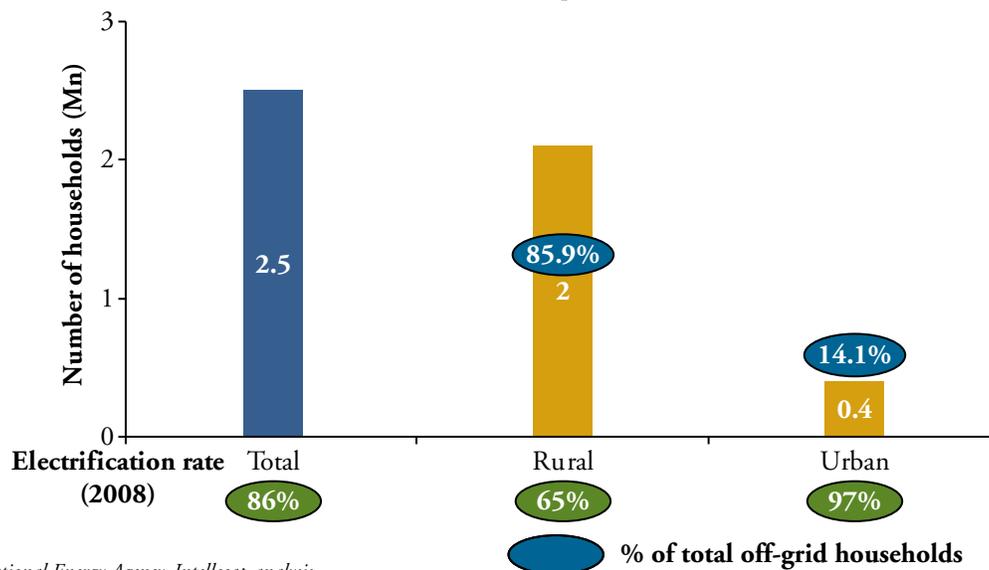
However, the market faces a threat from the high influx of poor quality products. Enterprises need to ensure that the consumers are educated about the importance of the product quality. There are ongoing efforts by the private sector to spread consumer awareness along with efforts to improve distribution, after-sales service, consumer financing and SME financing through collaborations.

## 8. Philippines Market Scoping

### 8.1 Current state of off-grid lighting

The Philippines has a population of approximately 90 million (or 19 million households) and has an electrification rate of 86%, which is very high in comparison to the other countries in this report. However,

there is still a sizeable off-grid population comprising of 2.5 million households. 86% of these households are located in rural areas where the electrification rate drops to 65%.



Source: International Energy Agency, Intelicap analysis

Figure 8.1: Distribution of off-grid Households in the Philippines (2008)

### Total annual expenditure on kerosene for lighting is USD 180 million

Based on a 2004 survey<sup>[70]</sup>, 44% of the Filipino households (off-grid and under-electrified) use kerosene for lighting. At the current price of approximately USD 1 per liter of kerosene, the total annual expenditure on kerosene for lighting is estimated at USD 180 million.

### 8.2 An overview of solar off-grid lighting market

There are few enterprises in the solar off-grid lighting market – across solar lanterns and SHS. Key suppliers of SHS in the Philippines are Pamatec, Gendiesel, Del Genta, Adtel Incorporated and SURE.

Compared to the SHS market, the lantern market is even smaller. Hybrid Solutions and Barefoot Power are considered to be the major enterprises here. Their products are being sold to households – both off-grid and under-electrified. There are also some occupations such as street hawkers and fishermen that are being targeted by the companies. As in other countries, there is a presence of sub-standard, cheap, imported lanterns in the country. However, the extent of their usage is difficult to estimate.

[70] Sources: Household Energy Consumption Survey, National Statistics Office, Philippines. 2004

## Companies are mainly dependent on government and donor programs

In the SHS market, a majority of the sales happen through public-private partnership programs such as the World Bank-funded Rural Power Project (RPP), Project BEACON<sup>[71]</sup>, AMORE<sup>[72]</sup>. Across these programs, an estimated 40,000 – 50,000 SHS have been deployed so far in the country. The different programs support these sales in two ways:

- Grant is given for free distribution of SHS. The customer is then made to pay for the SHS received through a lease-to-own model.
- High levels of subsidies are given for the purchase of SHS.

For example, in the RPP program, the government provides subsidies of USD 180 on a 20-30 Wp and USD 90 on a 30-50 Wp range SHS and does not provide anything for systems above 50 Wp. Additional subsidies are received from GEF which credits subsidies based on wattage and provides approximately USD 2.5/Wp for a 20-50 Wp SHS and approximately USD 1.5/Wp for 50-100 Wp and nothing for systems above 100 Wp<sup>[73]</sup>. Through these subsidies, an amount as high as 40-50% of the system procurement price is funded. The program was terminated in mid-2011 with no further plans to extend it.

In the solar lantern market, it is estimated that over 7,000 lanterns have been deployed, of which nearly 3,000 have come from the RRP program. Solar lanterns used to receive a government subsidy of USD 35 per lantern and a GEF grant of USD 2.5 per Wp. However, this was terminated in October 2009.

## Lease-to-own is an important distribution model for SHS in the country

Unlike in other countries, the lease-to-own model has been used by several prominent programs - AMORE, RPP, Solar Power Technology Supports Program (SPOTS)<sup>[74]</sup>, Philippines Rural Electrification Service Project (PRES)<sup>[75]</sup>, PNOC SHS Distribution Project<sup>[76]</sup> for SHS sales in Philippines.

This model has faced challenges due to the lack of ownership by most users. Their incentive to pay the lease amount as well as to ensure proper maintenance and usage of the SHS have been low. The lack of adequate maintenance personnel and facilities compounds the issues faced by this model, as well.

[71] BEACON – Barangay Electrification Assistance for Countryside Development

[72] Funded by USAID

[73] Source: End-user Finance for Access to Clean Energy Technologies in South and South-East Asia, Frankfurt School of Finance and Management, January 2011

[74] Program of the Department of Agrarian Reform (DAR) and British Petroleum (BP)

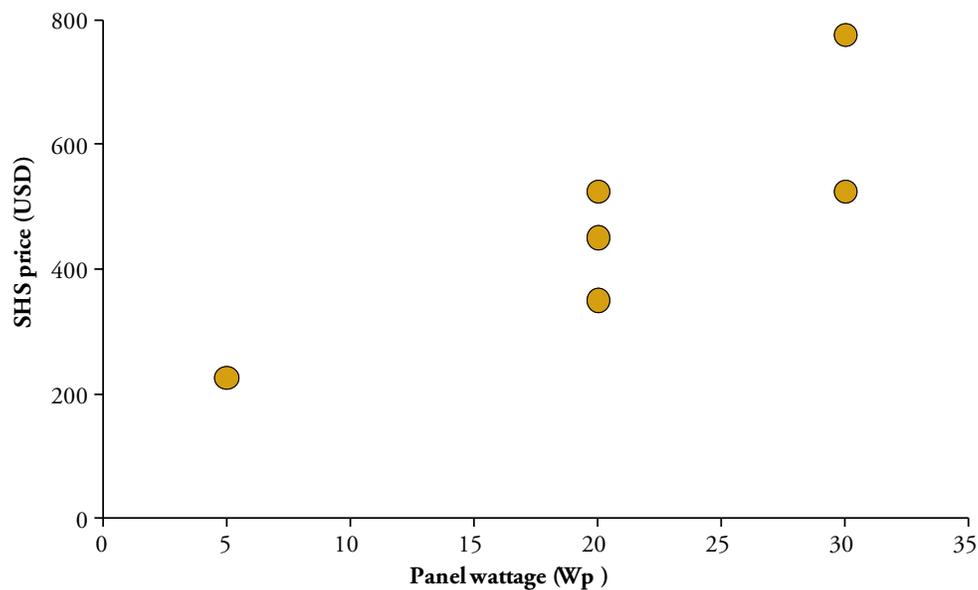
[75] Program of the French Filipino Loan Protocol, implemented by the Filipino company Pamatec

[76] Program of the Philippine National Oil Company (PNOC), Shell and the Dutch Government

20 Wp and 30 Wp SHS are the most widely sold versions in the country, as the government and donors had chosen them for distribution.

The 20-30 Wp products are available at a retail price of approximately USD 20 to USD 27 per Wp. The

non-subsidized price of the systems, available in Philippines, as compared to the other countries studied in this report is very high. For instance, a 20 Wp system in Bangladesh is available for approximately USD 165, while in Philippines, the non-subsidized 20 Wp system ranges from USD 450-550.



Source: Primary research, Intellectap analysis

**Figure 8.2: Retail price (non-subsidized) of SHS in the Philippines**

### Case study of lease-to-own model:

The USAID funded program AMORE provides energy services through SHS, PV charging stations and micro-hydro facilities. It was started in 2002.

Under this program, SHS were given out on a grant basis and community organizations were set up by USAID and trained to ensure proper operation and after-sales maintenance. Households had to pay a monthly lease-to-own fee (USD 2.2) over a period of five years, covering 25% of the cost of the SHS, thereby increasing the sense of ownership. In addition, households paid USD 2.3 for battery replacement, USD 1 for technical fees and transportation costs etc. The total monthly fees amounted to USD 5.5.

### Consumer finance beginning to see activity

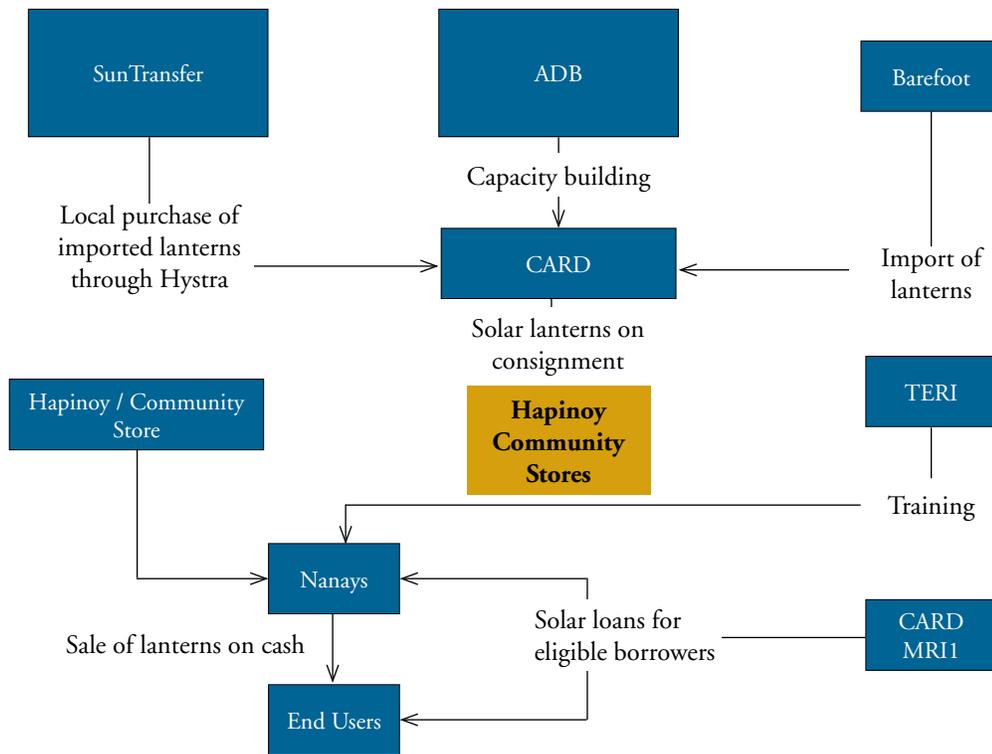
As most MFIs are located in urban centers, a large section of the rural population lacks access to finance. This lack of consumer finance in rural areas has made it difficult for solar off-grid lighting companies to increase their reach. There is increasing interest in providing microcredit in rural areas as seen in two recent efforts in the country:

#### CARD partnership with SunTransfer and Barefoot

CARD has entered into a partnership with SunTransfer and Barefoot to sell their respective solar lanterns through the wide network of Hapinoy community stores. Female

entrepreneurs – Nanays – are leveraged to sell lanterns to consumers on a consignment basis. CARD partnered with TERI to source and train technicians that provide after-sales services and maintenance.

During the pilot phase of six months, more than 300 solar lanterns had been sold for a unit price of approximately USD 70-90, 70% of which were sold through solar loans. CARD aims to increase its network to over 30 community stores in the near future.



**Note:** 1. CARD Mutually Reinforcing Institutions

Source: Primary and secondary research

**Figure 8.3: Schematic of CARD partnership with SunTransfer and Barefoot**

### Paglaum Multi-Purpose Cooperative and Gendiesel partnership

Paglaum Multi-Purpose Cooperative (PMPC), a large cooperative with approximately 40,000 members, has partnered with Gendiesel through the RPP. PMPC offers solar loans of USD 250 to 350 for a 20 Wp and 30 Wp SHS at a monthly interest of 2.5% and loan term of 2 years. It has so far sold approximately 40 SHS of Gendiesel. The cooperative is targeting to install another 200 SHS in 2011. It is also partnering with Hybrid Solutions to distribute lanterns and has so far sold approximately 100.

### 8.3 Overview of the regulatory environment

While the government and donor programs are encouraging only a few selected private sector enterprises, and the subsidy, being offered, only for certain product specifications, the programs end up hampering private sector enterprises from innovating both on products and business models. With the system prices in the Philippines much higher than that in other countries, the effectiveness of the subsidy program and the focus of the government on promoting competitive products come into question.

Solar panels, charge controllers and fluorescent lamps for both SHSs and lanterns are mainly imported often from China, however batteries are locally produced.

Import duties on solar photovoltaic cells, modules, panels and LEDs are quite low, thus encouraging local assembly of SHS. The import tariffs for solar lanterns vary from 5%-7%. VAT of 12% is considered high, and companies are lobbying with the government to remove VAT on solar systems.

Overview of the regulatory environment- Philippines			
	Status	Impact on SHS	Impact on solar lanterns
Financing support – Solar lighting products	<ul style="list-style-type: none"> <li>The market is dominated by government and donor funded programs providing subsidies on SHS</li> </ul>	<ul style="list-style-type: none"> <li>Supporting presence of few private sector players to serve the low income segment</li> <li>Restricting product specifications available in the market</li> </ul>	<ul style="list-style-type: none"> <li>No current impact as the subsidy for lanterns ran out in 2009</li> </ul>
Subsidies – conventional fuels	<ul style="list-style-type: none"> <li>No subsidy given out on kerosene, current price is ~USD 1 / litre</li> </ul>	<ul style="list-style-type: none"> <li>Absence of subsidy on kerosene allows fair competition for solar lighting</li> </ul>	
Import tariffs and duties / Taxation policies	<ul style="list-style-type: none"> <li>No import duty on solar photovoltaic cells, modules, panels and LEDs</li> <li>Import tariffs, 5-7% for solar lanterns</li> <li>Import duties on batteries are 15% and other components (controller, lights, wires) 3%</li> <li>Import duties on complete SHS vary from 0-7%</li> <li>VAT is 12%</li> </ul>	<ul style="list-style-type: none"> <li>Promotes local assembly of SHS</li> </ul>	<ul style="list-style-type: none"> <li>Since majority lanterns are imported, import duties hinder competitiveness</li> </ul>

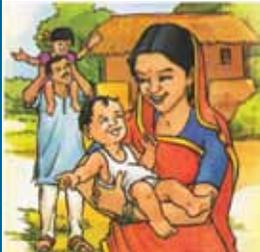
#### **8.4 Philippines conclusion**

Despite a relatively high electrification rate, the Philippines still has approximately 2.5 million off-grid households. Kerosene is the dominant source of lighting used by them. With the market penetration of SHS and lanterns being less than 2%, the Philippines could be a lucrative solar off-grid lighting market.

Private enterprises are beginning to look beyond government and donor schemes to tap the low-income segment of the market. An encouraging aspect to the private sector is that the government subsidies on the solar lighting products that are disrupting the market are going to end in 2011. This opens up the scope for further commercial models emerging in the market.

## 9. APPENDIX

### 9.1 Examples of successful social marketing in India

Issue / Problem	Intervention	Marketing Messages	Program Impact
<p><b>Unsafe drinking water</b></p> <ul style="list-style-type: none"> <li>Improve hygiene &amp; safe drinking water practices</li> <li>Better management of diarrheal cases</li> </ul> 	<p><b>Organization:</b> Safewat  <b>Product:</b> Water disinfectant product (chlorine solution), costing ~ USD .25  <b>Donor:</b> USAID (USD 200,000)  <b>Duration:</b> July '03-Dec'05  <b>Location:</b> Uttaranchal  <b>Customer Segment:</b> targeted households with young children</p>	<p><b>Social Message:</b> safe drinking water and better management of diarrhea  <b>Communication :</b> education on water-contaminated diseases, importance of clean drinking water  <b>Channels:</b> schools, stalls at fairs and public places, community water resources  <b>Partnerships</b> with health providers</p>	<p>19,350 bottles sold in 12 months          Targeted 2.5 lakh population</p> 
<p><b>Lack of sanitation</b></p> <ul style="list-style-type: none"> <li>Focused on demand creation, social marketing</li> <li>Provide access to credit</li> <li>Develop reliable supply of sanitation goods and services</li> <li>Redirection of subsidy from construction to hygiene promotion</li> </ul>	<p><b>Organization:</b> WaterAid  <b>Product:</b> low-cost pour flush pit latrine (~USD 40)  <b>Donor:</b> Supported by DFID  <b>Duration:</b> 1997-1998  <b>Location:</b> AP and Tamil Nadu  <b>Customer Segment:</b> targeted at school children who in turn convince their parents for a toilet</p>	<p><b>Marketing messages:</b> health benefits, privacy, convenience, safety, status / prestige, cost savings, income generation  <b>Partnerships</b> with schools to implement school health education program</p>	<p><b>Before intervention:</b> Only 460 toilets sold by WaterAid out of target of 1,100 in 12 months  <b>After:</b> 5,000 sold in 6 months</p> 

## 9.2 Estimation of the market penetration of Solar lanterns in India

	1997-02	2002-07	2007-10	Total
Cumulative PV module deployed for solar lanterns (MWp)	4.9	7.5 <sup>[i]</sup>	N/A	-
Average PV module rating assumed for a solar lantern (Wp)	approx. 10	approx. 10	N/A	-
No. of solar lanterns produced	490,000	750,000	approx. 1.2- 2 million	-
No. of solar lanterns exported	NA	259,000	187,000	-
No. of solar lanterns imported	Assumed negligible	35,000 <sup>[ii]</sup>	368,000	
Solar lanterns sold through subsidized programs	335,000	67,259	400,000	800,000
Total no. of solar lanterns sold / distributed in India	490,000	526,500	approx. 1.2 – 2. million	approx. 2.3 – 3.2 million

**Note:**

Export data from 1997-02 is unavailable. Imports from 1997-02 are estimated to be negligible as the imports in 2004 were very low (approx. 15,000 units). Final sales estimates till 2010 could be higher or lower by 5-10% owing to this assumption

Assuming average annual sales of 300,000 - 500,000 solar lanterns per year from 2007-2010 (based on primary research and TERI survey- detailed further below); one can expect 2-3 million lanterns to have been deployed so far. These numbers do not account for any sales prior to 1997 but the number is expected to be small

**Sources:**

[i]. Solar PV Industry Global and India Scenario, The Photovoltaic Program in India (MNRE);

[ii]. Data available from 2004-2006 only; Ministry of Commerce, Export Import Data Bank, Primary research, Intellectap analysis

### 9.3 Estimation of the market penetration of SHS in India

	1997-02	2002-07	2007-10	Total
Cumulative PV module deployed for SHS (MW <sub>p</sub> )	9.2	16.5	N/A	-
Average PV module rating assumed for a SHS (W <sub>p</sub> )	approx. 35 <sup>[i]</sup>	approx. 35	-	-
No. of SHS produced	262,857	471,429	-	-
No. of SHS exported	-	-	-	-
No. of SHS imported	-	-	-	-
SHS sold through subsidized programs	165,000	107,000	347,000	619,428
Total no. of SHS sold / distributed in India	262,857	471,429	approx. 300,000- 400,000 <sup>[ii]</sup>	approx. 1 – 1.2 million

*Note:*

[i]. MNRE specifications for SHS are 18 W<sub>p</sub>, 37 W<sub>p</sub>, 74 W<sub>p</sub>

[ii]. Tata BP Solar has sold approx. 100,000 SHS from 2007-2010; Primary research indicates that Tata BP Solar SHS sales constitute 25-30% of the market

*Source:*

Solar PV Industry Global and India Scenario, The Photovoltaic Program in India (MNRE), Ministry of Commerce- Export Import Data Bank, Primary research, Intellecap analysis

#### 9.4 Proposed JNNSM program of Ministry of New and Renewable Energy in India

This is a program that was launched in November 2010 and performance is yet to be seen. An earlier demonstration program by NABARD and RRBs achieved a disbursement of 38,000 systems in FY 2009-10 (against a target of 120,000 systems) with over 80% of sales being in UP (and nearly 70% of the State sales happening through one bank – Aryavart Gramin Bank).

Key characteristics of the program:

- This program is available for only SHS
- Subsidy amount is limited to USD 6.5/Wp (INR 300/Wp) for SHS
- Systems up to a limit of 1 kWp can be supported through this scheme

Following are the sequence of steps and the flow chart representation of the RVSLP program:

- Customer approaches the RRBs/SCBs to avail a loan
- Banks sanction loan and capital subsidy as per guidelines for MNRE specified products
- Banks raise refinance for the loans extended by them on a monthly basis from NABARD
- NABARD raises finance from IREDA on a regular basis as needed for meeting refinancing needs of the banks
- Customer pays back the loan at 5% interest over up to 5 years

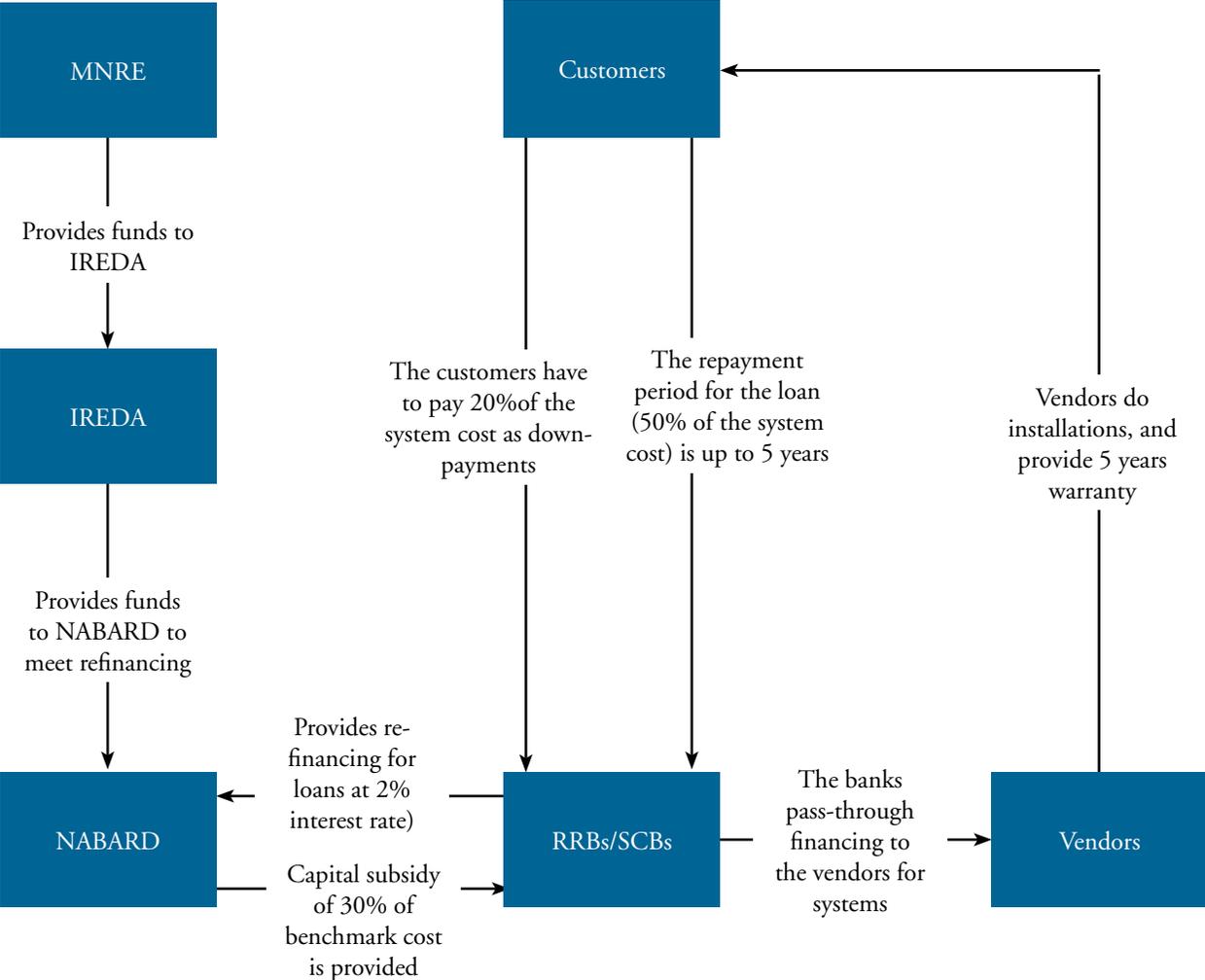


Figure 9.1: Schematic diagram of JNNSM program in India

## 9.5 Price points of CFL based solar lanterns in India

Ritika Systems	• 5 W panel, 5 W lamp, 250 lumen, 6 V 4.5 Ah Lead Acid battery (USD 31)		• 10 W panel, 7 W lamp, 427 lumen, 12 V 7 Ah lead acid battery (USD 57)	
Solid Solar	• 8 W panel, 7 W lamp, 6 V 9 Ah Lead Acid battery (USD 40) <sup>[1]</sup>	• 5 W panel, 5 W lamp, 6 V 4.5 Ah Lead Acid battery (USD 42) <sup>1</sup>		• 10 W panel, 9/7 W lamp (USD 93)
Reliance Industry				• 10 W panel, 7 W lamp 371 lumen, 12 V 7 Ah Lead Acid battery (USD 97)
Arsh Electronics				• 10 W panel, 7 W lamp 420 lumen, 12 V 7 Ah (USD 68)
Solkar		• 5 W panel, 150 lumen (USD 44)		
Jain Irrigation				• 10 W panel, 7 W lamp 371 lumen, 12 V 7.5 Ah (USD 90) • 10 W panel, 9 W lamp 558 lumen, 12 V 7.5 Ah (USD 95)
Suntechnics Energy Systems			• 10 W panel, 7 W lamp 371 lumen, 12 V 7 Ah (USD 59)	
BPL Solar	• 7 W panel, 1 lamp (USD 22) • 6 W panel, 2 tube lights (USD 29)	• 11 W panel, 1 lamp (USD 32)		

Price Range

Up to USD 30      USD 30-40      USD 40-50      USD 50-60      Over USD 60



Note: 1. Lumen output date unauthenticated

Sources: TERI, the solar quarterly

## 9.6 Price points of LED based solar lanterns in India

Greenlight	• 0.7 W panel, ~60 lumen (USD 19)				
Global Telelinks		• 3 W panel, 100 lumen (USD 33)	• 5 W panel, 100 lumen (USD 44)		
Ritika Systems	• 2 W panel, 110 lumen (USD 26)	• 3 W panel, 180 lumen (USD 35) • 3 W panel, 280 lumen (USD 39)	• 3 W panel, 350 lumen, 2.5 W LED (USD 44) • 3 W panel, 330 lumen, 3 W LED (USD 47)		
Solid Solar				• 2 W panel, 100 lumen (USD 54) • 3 W panel, 100 lumen (USD 56) • 5 W panel, 150 lumen (USD 56)	• 3 W panel 120 lumen (USD 61) • 3 W panel, 120 lumen (USD 64) • 3 W panel, 120 lumen (USD 66) Price diff. based on lamp size
Avni Energy		• 3 W panel, 180 lumen (USD 33)		• 8 W, 360 lumen (USD 54)	
Moser Baer				• 3 W, 128 lumen (USD 54)	
Solkar Solar			• 3 W panel, (USD 44) • 3 W panel, (USD 46)		
Reliance Industry					• 3.3W panel, 200lumen (USD 70)
Suraj Solar	• 3 W panel, 240 lumen (USD 29)				
Halonix				• 5 W panel, 225 lumen (USD 54)	



Sources: TERI, the solar quarterly

### 9.7 Price points of SHS in India

SELCO		• 10 W panel, 1 CFL light (USD 174)			SELCO offers products with prices up to USD 1,020 with 10 lights
Barefoot	• 2.5 W panel, 2 LED lamps, 120 lumen (USD 37)	• 5 W panel, 4 LED lamps (USD 106)	• 15 W panel, 2 TL, 2 LED (USD 214)		
Tata BP Solar			• 18 W panel, 2 CFL light (USD 265)	• 37 W panel, 2 CFL light (USD 325)	• 75 W panel, 2 CFL light (USD 590)
InteliZon		• 12 W panel, 1 LED, 330 lumen, (USD 118) • 18 W panel, 3 LED, 465 lumen, (USD 180)			
Solkar			• 15 W panel, 3 LED lights, 300 lumen (USD 224)	• 2* 15 W panels, 3 LED lights, 300 lumen (USD 347)	• 3* 15 W panels, 3 LED lights, 300 lumen (USD 510) • 4* 15 W panels, 3 LED lights, 300 lumen (USD 612)
Su-Kam	• 3 W panel, 2 LED lights, 75-90 lumen (USD 82)				
Philips			• 18 W panel, 2 LED light (USD 220)		
Schneider		• 4.5 W panel, LED (USD 107)			
Duron		• 5 W panel, 3 LED lights (USD 130)			
Advait		• 10 W panel, 2 LED lights (USD 102)	• 20 W panel, 4 LED lights (USD 204)	• 30 W panel, 6 LED lights (USD 306)	



Sources: TERI, the solar quarterly

### 9.8 List of organizations interviewed for primary research

Country	Category	Organization
Global	Solar lighting companies	<ul style="list-style-type: none"> <li>Barefoot Power</li> <li>Frankfurt School of Management</li> </ul>
	Development and donor agencies / NGOs	<ul style="list-style-type: none"> <li>ADB</li> <li>UNEP</li> </ul>
	Industry experts	<ul style="list-style-type: none"> <li>IFC Lighting Africa team</li> </ul>
India	Solar lighting companies	<ul style="list-style-type: none"> <li>Advait Energy</li> <li>D Light</li> <li>Duron</li> <li>InteliZon</li> <li>Greenlight Planet</li> <li>Philips</li> <li>Prakruti Power</li> <li>Schneider Electric</li> <li>SELCO</li> <li>Simpa Networks</li> <li>Solkar</li> <li>Tata BP Solar</li> <li>Visual Lighting Equipment</li> </ul>
	Government (or affiliated organizations)	<ul style="list-style-type: none"> <li>MNRE</li> <li>TERI</li> </ul>
	Development and donor agencies / NGOs	<ul style="list-style-type: none"> <li>Shell Foundation</li> <li>LED Foundation</li> </ul>
	Financiers (investors, banks and MFIs)	<ul style="list-style-type: none"> <li>World Bank</li> <li>Yes Bank</li> <li>Indiaco</li> </ul>
	Industry experts	<ul style="list-style-type: none"> <li>Ecoforge</li> <li>New Ventures India</li> <li>IFMR</li> <li>Crestar Capital</li> </ul>

Country	Category	Organization
Bangladesh	Solar lighting companies	<ul style="list-style-type: none"> <li>• Allied Solar</li> <li>• Rahimafrooz</li> <li>• Grameen Shakti</li> <li>• Rural Services Foundation</li> </ul>
	Government (or affiliated organizations)	<ul style="list-style-type: none"> <li>• IDCOL</li> </ul>
	Financiers (investors, banks and MFIs)	<ul style="list-style-type: none"> <li>• Grameen Shakti</li> <li>• Rural Services Foundation</li> </ul>
Nepal	Solar lighting companies	<ul style="list-style-type: none"> <li>• Sunshine Energy</li> <li>• Lotus</li> <li>• Solar Electric Company / Nepal Solar Energy Society</li> <li>• Surya Power Company</li> </ul>
	Government (or affiliated organizations)	<ul style="list-style-type: none"> <li>• AEPC</li> </ul>
	Development and donor agencies / NGOs	<ul style="list-style-type: none"> <li>• Ace Development Bank</li> <li>• SNV</li> <li>• Winrock Nepal</li> </ul>
Pakistan	Solar lighting companies	<ul style="list-style-type: none"> <li>• Solar Systems Pakistan</li> <li>• Pakistan Solar Power</li> </ul>
	Government (or affiliated organizations)	<ul style="list-style-type: none"> <li>• AEDB</li> </ul>
	Development and donor agencies / NGOs	<ul style="list-style-type: none"> <li>• GIZ</li> <li>• Winrock Pakistan</li> <li>• UNIDO</li> </ul>
	Financiers (investors, banks and MFIs)	<ul style="list-style-type: none"> <li>• Tameer Bank</li> </ul>
	Industry experts	<ul style="list-style-type: none"> <li>• Renewable Energy Association</li> </ul>

Country	Category	Organization
Cambodia	Solar lighting companies	<ul style="list-style-type: none"> <li>• Kamworks</li> <li>• Yejj Solar</li> <li>• SME Renewable</li> <li>• Khmer Solar</li> </ul>
	Government (or affiliated organizations)	<ul style="list-style-type: none"> <li>• Rural Electrification Fund</li> </ul>
	Development and donor agencies / NGOs	<ul style="list-style-type: none"> <li>• GRET</li> <li>• GERES</li> <li>• Pico Sol</li> </ul>
	Financiers (investors, banks and MFIs)	<ul style="list-style-type: none"> <li>• IFC</li> <li>• AMK Cambodia</li> <li>• Sathapana</li> <li>• Aceda</li> </ul>
	Industry experts	<ul style="list-style-type: none"> <li>• KC Strategy Design</li> </ul>
Indonesia	Solar lighting companies	<ul style="list-style-type: none"> <li>• Contained Energy</li> <li>• Sundaya Indonesia</li> <li>• Petrosea</li> <li>• PT Bangun Baskara Mandiri</li> <li>• Wika Intrade</li> <li>• Azet Surya Lestari</li> <li>• Schneider Indonesia</li> </ul>
	Government (or affiliated organizations)	<ul style="list-style-type: none"> <li>• Indonesian Committee for CDM</li> <li>• Kadin Business Support Desk</li> </ul>
	Development and donor agencies / NGOs	<ul style="list-style-type: none"> <li>• YBUL</li> <li>• UNEP</li> </ul>
	Investors	<ul style="list-style-type: none"> <li>• Planet Finance</li> <li>• Bank Rakyat Indonesia</li> </ul>
	Industry experts	<ul style="list-style-type: none"> <li>• New Ventures Indonesia</li> <li>• Asian Pacific Energy Group</li> </ul>

Country	Category	Organization
Philippines	Solar lighting companies	<ul style="list-style-type: none"> <li>• Gendiesel</li> <li>• First Philec</li> <li>• Pamatec</li> <li>• Del Genta Philippines</li> <li>• Adtel Energy</li> <li>• Hystra Philippines</li> <li>• Solutions Using Renewable Energy</li> </ul>
	Government (or affiliated organizations)	<ul style="list-style-type: none"> <li>• Electric Power Industry Management Bureau</li> <li>• Renewable Energy Association</li> <li>• Rural Power Project</li> <li>• AMORE</li> </ul>
	Development and donor agencies / NGOs	<ul style="list-style-type: none"> <li>• USAID</li> <li>• Negros Women for Tomorrow</li> </ul>
	Financiers (investors, banks and MFIs)	<ul style="list-style-type: none"> <li>• Bank of the Philippines Islands</li> <li>• Paglaum Multi Purpose Cooperative</li> <li>• IFC</li> <li>• CARD Foundation</li> <li>• Microfinance Council of the Philippines</li> <li>• MICRA</li> </ul>

**9.9 Table summarizing the relationship between kerosene prices (based on consumption) and panel wattage of solar lanterns and SHS**

	Wattage	Lifespan	Product cost and battery cost over lifespan (USD)	Number of kerosene lanterns considered	Kerosene price considered	Kerosene expenditure per month (USD)
<b>Solar lanterns</b>	0.5 W <sub>p</sub> , 0.7 W <sub>p</sub> and 2 W <sub>p</sub>	3	18 to 46	1	PDS	USD 1.05 (@ USD 0.26 per liter and 4 liters per lantern)
<b>Solar lanterns</b>	3 W <sub>p</sub>	3	154	2	Blended (PDS and retail)	USD 4.1 (@ USD 0.26 per liter in PDS 0.76 per liter in retail and 4 liters per lantern)
<b>SHS</b>	5 W <sub>p</sub> and 15 W <sub>p</sub>	10	310	3	Blended (PDS and retail)	USD 7.2 (@ USD 0.26 per liter in PDS 0.76 per liter in retail and 4 liters per lantern)

A maximum of 4 liters of kerosene per household is assumed to be available for PDS price (USD 0.26 per liter).



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