



SCIENTIFIC ADVISORY PANEL BRIEFING: KEROSENE LAMPS & SLCPS

EXECUTIVE SUMMARY

About 3 billion people still use solid fuels (firewood, dung, crop residues and others) for basic energy needs such as cooking and home-heating. About 1.3 billion among this 3 billion lack access to electricity and rely on fuel-based (as opposed to electricity-based) lamps for lighting. The rest of the 1.7 billion have access to grid-based electricity but are considered to be under-electrified since the supply of electricity is unreliable and intermittent at best and hence many in this population also use fuel-based lamps as secondary source. The precise number of people depending on fuel-based lamps is not known, but if we combine the 1.3 billion un-electrified with the 1.7 billion under-electrified people, the number depending on fuel based lamps must fall in the range of 1.3 billion to 3 billion people or roughly 250 million to 500 million households.

Kerosene is the predominant fuel used in the fuel-based lamps. Users of kerosene lamps pay a huge price in terms of human wellbeing: in the form of injuries from burns, poisonings of children, health impacts from kerosene combustion products such as particulate matter (PM); insufficient illumination for education of children. The efficiency of these lamps (measured in lumens per watt of primary energy) as well as the illumination (lumens per square meter) are a factor of 10 to 100 lower than electric lamps such as LEDs and fluorescent bulbs. At a cost of \$1 per liter (unsubsidized) of kerosene, the lifetime cost of kerosene lamps are greater than those of solar lighting systems or lighting that depends on grid based electricity. Estimates of the global consumption of kerosene for lighting range from 5 to 65 Mt (million tonnes), costing about \$4 to \$40 billion per year. To increase affordability, kerosene is heavily subsidized, with unintended consequences to the economic well being of the countries. In spite of the subsidies, the poor households that lack access to grid-electricity earn less than \$1/day/capita and hence spend a disproportionately larger percentage of their income on lighting.

To this long list of adverse consequences, a new major environmental impact of kerosene lighting has been identified recently. This study, Lam et al. (2012), used laboratory and other available socio-economic data, to conclude that kerosene lamps are a major source of indoor and ambient black carbon (BC) in developing countries (about 6% of currently estimated anthropogenic total BC emissions). More importantly, it showed that burning of kerosene in lamps leads to emissions of almost pure BC (without the co-emitted cooling organic carbon particles), thus making PM from kerosene a very efficient absorber of solar radiation and a major contributor to regional positive climate forcing (warming). The Lam et al. study adopted the lower estimate of 5 Mt for kerosene consumption and concluded that kerosene lamps emit about 0.27 Mt of black carbon and exert a climate forcing as large 0.6 Wm^{-2} over parts of South

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This document and more information on the CCAC are available at: www.ccacoalition.org or www.unep.org/ccac.

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Asia, the largest user of kerosene lamps. However, given the large uncertainty in global kerosene consumption, such estimates must be considered preliminary and likely a lower bound for the climate forcing of BC particles emitted by kerosene lamps. The CO₂ produced from burning kerosene also causes positive climate forcing. Reduction of kerosene use for lighting would hence contribute to efforts to mitigate near-term climate change. It will also mitigate long-term climate change if the kerosene lamps are replaced with solar lamps or electricity produced with fossil fuels. For example, the CO₂ emission per unit of light from a kerosene lamp is one to two orders of magnitude greater compared with that from fluorescent lamps. The reduction in South Asian BC can also potentially provide large climate benefits via reduction of the disruption of traditional regional rainfall patterns, including the Indian Monsoon, as well as reduction of the melting of the Himalayan glaciers by BC deposition.

In short the social imperatives for proper lighting and cleaner lighting sources are immense. The positive side of the kerosene lamp story is that off-the-shelf, cost effective and scalable technologies are available to eliminate the use of kerosene lamps, resulting in multiple co-benefits to human health, livelihood and climate. Off-grid solutions, using either individualized solar photo-voltaics or mini-grids with fluorescent or LED lighting, offer the most expedient, efficient, cost-effective and environment-friendly way to bring the 1.3 billion or more people using kerosene lamps into the modern era with respect to illumination inside homes. Villages in South Asia and Africa, covering perhaps over a million homes, have already started adopting such off-grid solutions. The challenge is to scale up to the much larger population using fuel-based lamps. The CCAC could partner with UN's *Sustainable Energy for All* initiative to promote the deployment of off-grid solar lamp systems to the 1.3 billion without access to electricity. In this report, we consider India as an example, and provide quantitative analyses for the cost effectiveness of off-grid solutions. India has about 400 million people (about 80 million households) that are not on the grid and use kerosene lamps instead. Kerosene is subsidized by the government such that the rural poor buy it at a third of the actual cost. Our analyses suggests that about two-years worth of the kerosene subsidy may be sufficient to provide off-grid (or mini-grid) solar lamps for all of the 80 million households.

We conclude that no other major BC source has such a combination of readily available alternatives and definitive climate forcing effects. Given the large economic, development and environmental benefits associated with emissions reductions, replacement of kerosene-fueled wick lamps with fluorescent bulbs or LEDs serviced by low-carbon grid-based electricity or off-grid photovoltaics deserves strong consideration for programs that target short-lived climate pollutants.

We recommend the following actions to mitigate SLCPs:

- Design mechanisms to accelerate a transition to the win-win solution of low-carbon grid-based or off-grid electricity supply for lighting services.
- Identify and implement optimal methods to lower emissions associated with the combination of residential energy use for cooking, heating and lighting.

We also recommend additional research to fill the gaps in our knowledge, though these do not preclude immediate action:

- Evaluate global kerosene consumption for lighting in order to reduce the large uncertainty (factor of 13).
- Promote studies of emissions of BC and other pollutants including ozone (another SLCP), and precursor pollutants such as NO_x, CO, and VOCs from burning of kerosene.

- Promote studies of regional climate effects of BC from kerosene burning and regional BC-related emissions in general.
- Promote socio-economic studies to understand the impact of switching from kerosene lamps to better and less polluting lamps would have on health, education, and income generation amongst the poorest 1.3 billion of the world population who depend on fuel-based lamps.
- Promote research to enable definitive conclusions regarding risk related to kerosene use (combustion, burns, poisoning) and for quantifications of risk estimates.

I - Introduction

Kerosene is an important household fuel which is widely used in developing countries for lighting and to a lesser degree for cooking. Global estimates suggest that approximately 250 to 500 million households (1/3 to 1/5th of the world population) rely on kerosene or other liquid fuels for lighting,¹ consuming 5 to 65 million tonnes (Mt) of kerosene per year, producing an estimated 40 to 500 Mt of CO₂, as well as black carbon (BC) and other pollutants.² As indicated by the range above, there is nearly a factor of 13 discrepancy between recent studies on the consumption of kerosene.^{1,3} In India, one-third of rural households and 5% of urban households reported kerosene as their primary lighting source with higher use in lower socioeconomic groups.⁴ In Africa kerosene use is also prevalent with ~55 million households (~290 million individuals) dependent upon kerosene as their primary lighting source.⁵ Although less common than its use for lighting and cooking in developing countries, kerosene also is used as a heating fuel in some households in developed countries (USA, Chile, Japan), with studies indicating that this results in elevated indoor levels of PM, CO, NO_x, and HCHO.

The kerosene lamps commonly used in households in South Asia, Africa, and parts of Latin America have been confirmed to be a major source of indoor BC air pollution in these regions. Controlling this source would reduce air pollution while providing regional and global climate benefits. And of particular interest to policymaking, kerosene lamps have affordable alternatives that pose few clear adoption barriers and would provide immediate benefit to user welfare. A comprehensive view of residential energy use would help identify optimal methods to lower emissions associated with lighting as well as cooking and heating.

Kerosene-fuelled wick lamps used in millions of developing-country households are a significant but overlooked source of BC emissions according to a recent study.³ New laboratory and field measurements show that 7–9% of kerosene consumed by simple wick lamps is converted to carbonaceous particulate matter that is nearly pure BC. These high emission factors increase previous BC emission estimates from kerosene by 20-fold, to 0.27 Mt/year (0.11 – 0.59 Mt/year), which is about 6% (2-12) of currently estimated anthropogenic total BC emissions.³

II - Radiative Forcing

The high emitting regions for kerosene BC are South Asia, Africa and parts of Latin America, where these emissions represent a significant part of total BC emissions. BC is an efficient absorber of solar radiation and hence addition of black carbon increases the solar absorption by the earth-atmosphere system and contributes to a warming of the atmosphere and the surface. However, many BC sources also emit organic aerosols. Many of the organic aerosols primarily reflect solar radiation back to space, which cools the surface-atmosphere system. As shown in the recent Lam et al. study, the emission of organics by kerosene lamps is negligible, and hence the warming effects of BC dominate.

Global mean aerosol climate forcing on the atmosphere and snow from the kerosene-lighting source has been estimated recently at 22 mW m⁻² (8 – 48 mW m⁻²) (mW m⁻²) milliwatts per square meter), or ~5-10% of BC forcing by all other energy-related sources.³ The global mean reduction in forcing that could be achieved by replacing kerosene lighting is thus relatively small, but can be part of a suite of emissions reduction measures that can lead to large benefits. Furthermore, the forcing numbers of Lam et al. are based on the conservatively lower range of the 5 to 65 Mt of kerosene consumption, and had they used the higher value of 65Mt recommended by Mills,¹ the forcing number would be substantially larger. Even with the lower

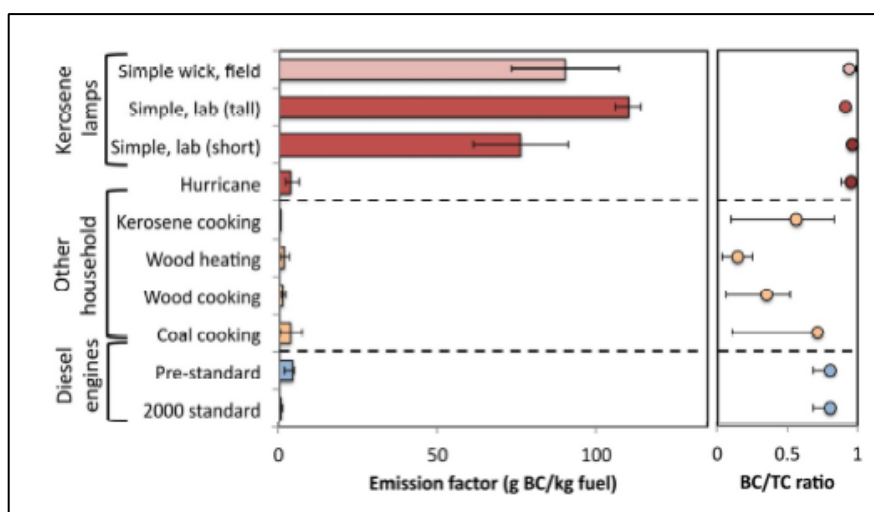
value of Lam et al., a large regional forcing reduction of 400 to 600 mW m⁻² could be realized in South Asia leading to substantial benefits in terms of reduced disruption of the traditional hydrologic cycle and the melting of the glaciers.^{6,7} Follow-on studies are needed to validate the numbers and better characterize the regional rainfall and glacier responses, but the qualitative conclusions appear robust. The CO₂ produced from burning kerosene leads to additional positive forcing, on the order of 5-45 mWm⁻² over the century following each year's emissions at current rates, and hence can contribute to the achievement of long-term climate protection goals.

III - Revised Emission Estimates

Of particular concern are the CO₂ and health-damaging pollutant emissions of kerosene as a lighting source. Emissions estimates of PM (all of which is <1 um in aerodynamic diameter) from kerosene lanterns range from 3 - 10 mg/g. Levels of PM_{2.5} resulting from use of wick-type lamps exceed WHO air quality guidelines, often substantially.

Kerosene lamp emissions of BC specifically are also of concern, for both their health and climate impacts. Available estimates were recently assessed by Lam et al. (*see* Figure 1). Using a thermal optical measurement method, elemental carbon (EC) was found to compose the majority (approximately 80%) of aerosol carbon taken from an unspecified type of lamp burning kerosene.⁸ In another study, photoacoustic measurements of particle light absorption from a simple kerosene lamp, similar to a hurricane design, indicated that emitted particles were highly light-absorbing (single scattering albedo = 0.20 at 532 nm), suggesting a high proportion of BC.⁹ Optical properties of kerosene particles from the lamp were suggested to be similar to those of diesel soot. As shown in the Lam et al. compilation, per kg of fuel consumed, kerosene lamps produce one to two orders of magnitude more BC. Another unique characteristic is that the kerosene lamps produce the largest fraction of BC compared with the total carbon, TC [sum of black and organic carbon] of all the black carbon sources. Since some of the organic aerosols have a cooling effect on climate, kerosene lamps can exert the largest warming effect per kg of fuel consumption, compared with other sources of BC.

Figure 1 - High Ratio of BC/TC from Kerosene Lamps Compared to Other Major BC Sources³



The high ratio of BC to TC from kerosene lamps increase previous BC emission estimates from kerosene by 20-fold, to 0.27 Mt/year (0.11 – 0.59 Mt/year), which is about 6% (2-12) of currently estimated anthropogenic total BC emissions.³ The revised BC emissions estimates for kerosene lamps are comparable in magnitude with BC emissions from some of the other major anthropogenic source categories examined in the 2011 UNEP & WMO assessment (see Table 1).⁶ However, given the large uncertainty in global kerosene consumption, such estimates must be considered preliminary and likely a lower bound for the BC emitted by kerosene lamps.

Table 1 - Anthropogenic BC Emissions For The Year 2005 (Mt/yr)⁶

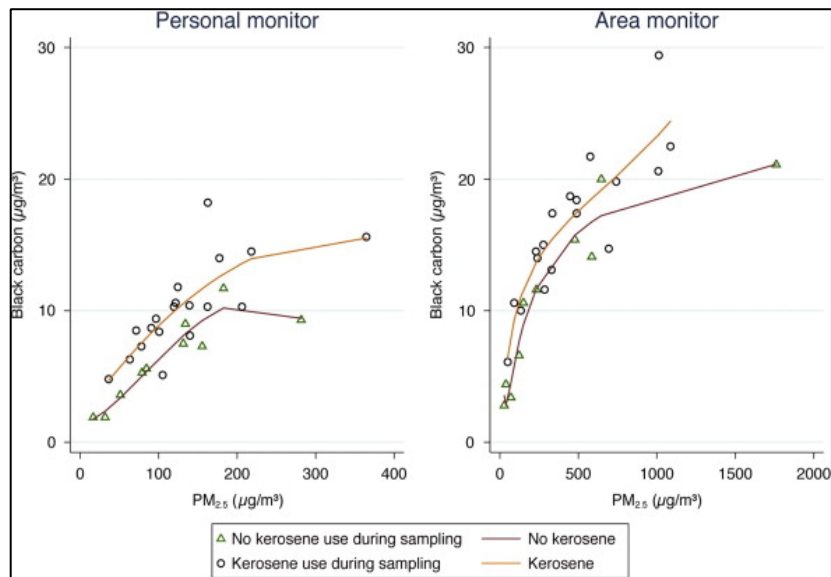
	BC
Large-scale combustion	0.10
Industrial processes	0.43
Residential-commercial combustion	2.7
Transport	1.6
Fossil-fuel extraction and distribution	0.28
Waste/landfill	0.1
Agriculture	0.31
<i>Kerosene Lighting</i>	<i>0.27</i>

IV - Exposure to PM from Kerosene Used for Lighting

While the global emissions of health-damaging air pollutants (PM_{2.5} including BC, CO, VOCs, formaldehyde, NO_x, SO_x), some of which are SLCPs, from kerosene may be lower than those from solid fuels, there are growing concerns regarding the health impacts of poisonings, burns and fires related to the use of kerosene indoors as well as from exposure to air pollutants emitted during kerosene combustion.

Although data are limited, a few studies have quantified the effects of lighting on indoor air quality. Two studies using mock setups to represent real-world conditions analyzed simple and hurricane lamps operated at “normal” wick height resulted in steady-state indoor PM concentrations of 2500 ± 900 and 6700 ± 1800 µg/m³, respectively.¹⁰ Operated at high wick settings, these levels rose to 5000 and 21,800 µg/m³, respectively, suggesting the plausibility of very high exposures resulting from kerosene lamp use. A 2013 study of PM_{2.5} and BC exposure in households cooking with biomass fuels in Ghana, found that households using kerosene for lighting “had consistently higher personal and kitchen area concentrations of black carbon (4 mg/m³ higher)” than those that relied on other forms of lighting, regardless of the type of biomass used for cooking (see Figure 2).¹¹

Figure 2 – Increased Exposure to BC Due to Kerosene Lighting¹¹



“Black carbon concentrations for personal and area samples across households reporting kerosene lantern use and households reporting no kerosene lantern use during exposure monitoring period. A fractional polynomial fit was used to allow a semi-quantitative comparison of black carbon exposures as a function of PM_{2.5} level indicating that both personal and kitchen samples were similarly enriched by black carbon when kerosene use was reported.”

V - Health Impacts of Kerosene

Lam et al., reviewed the evidence regarding health impacts related to kerosene combustion³ which was also summarized in the WHO review.¹² Relatively few epidemiologic studies have been conducted to assess the impact of kerosene combustion products on health. Studies of respiratory health effects conducted in developing country settings have generally been inconclusive with a number of studies indicating null effects. A number of the most recent studies, however, suggest increased risk of wheeze¹³ and night cough, phlegm and rhinitis (but not wheeze)¹⁴ for kerosene stove users compared to those using LPG or electricity as cooking fuels. Studies conducted to evaluate the impact of kerosene heaters in the U.S. where indoor concentrations are much lower do suggest a small increased risk of respiratory symptoms (wheeze, chest tightness) amongst infants and their mothers for kerosene use and increased concentrations of SO₂ in their homes.¹⁵

Several large studies conducted in Ethiopia indicate increased risk of asthma and allergic diseases in association with kerosene stove use compared to biomass users,¹⁶ although there were a relatively small number of exclusive kerosene users. Studies of acute respiratory infections, arguably the most important respiratory health effect in developing country settings are limited but do not suggest an increased risk associated with kerosene use. Similarly, little information is available regarding potential impacts of kerosene use on tuberculosis (TB). A single, small study that evaluated kerosene use in regard to cataracts did report an increased risk compared to electricity use.¹⁷ With regard to cancer, the International Agency for Research on Cancer reviewed the available evidence in 1989 and concluded that there was inadequate human and limited animal evidence for carcinogenicity of kerosene.¹⁸ In addition, the WHO Guidelines summarized four new additional epidemiologic studies published since the Lam et

al., and these latest studies reported increased risks among kerosene users compared to clean fuel users (LPG/electricity) for stillbirth, low birth weight, neonatal deaths, cataracts and childhood acute lower respiratory infections.¹² Studies of health effects related to kerosene lamp use specifically are very limited. One of two conducted in Nepal¹⁷ reported a strong association with TB risk, and one study in India, described a strong, albeit unadjusted for other risk factors, association with acute lower respiratory infections in children.¹⁹

Together, the Lam et al. and WHO reviews reported suggestive evidence that kerosene use increased the risk of cancer, respiratory infections, asthma, TB, and cataracts, but that methodological quality and results were highly variable. Overall, the levels of emissions of, and exposure to, health damaging pollutants were consistent with significant risk of adverse health outcomes related to emissions from kerosene appliances, however the epidemiological evidence was of low quality and further research is needed to enable definitive conclusions regarding risk and for quantifications of risk estimates.¹²

Kerosene Burns & Poisoning

In addition to concerns related to health impacts of emissions of air pollutants from the use of kerosene appliances are the risks of burns, fires and poisonings associated with household use of kerosene. Poisonings from ingestion of kerosene, especially in children, are common in developing countries, in part due to the storage of kerosene in small unlabeled containers or soft drink bottles. Kerosene poisoning has been well summarized previously.²⁰ Most kerosene poisonings are non-fatal, although aspiration of ingested kerosene can be fatal. Nevertheless, kerosene poisonings are thought to make up a significant portion of total poisoning incidents each year, particularly in developing countries.

Pokhrel et al. reviewed the fire and burn risks associated with kerosene.²¹ These risks are often exacerbated by the use of kerosene appliances in crowded housing that is constructed with highly combustible material. Further, the common placement of kerosene stoves on the floor can make spillage and rapid spread of a fire more likely, while loose-fitting flammable clothing may increase burn risks.

The WHO systematic review of burns and poisoning concluded that there was good evidence that household use of kerosene is an important cause of burns and fires, and of poisoning of children drinking the fuel in low and middle income countries.²² However, reliable population-based data on rates, injuries and associated factors were found to be lacking. Similarly, a small number of (randomized and non-randomized) experimental studies have investigated the impact of safety programmes on kerosene-related injury risk, but this body of evidence was not found to be sufficient to derive reliable estimates of the effect of such interventions.

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The Transition from Kerosene to Solar Energy

REGIONAL EXAMPLES IN INDIA AND AFRICA

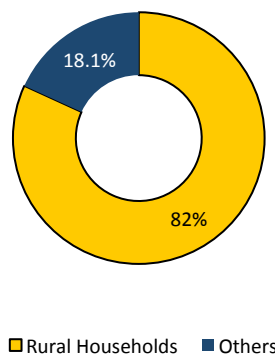
1 - India¹

Access to energy, particularly electricity, is considered as one of the most important factors for socio-economic development of a country. It is widely accepted that inadequate access to affordable energy, presents a substantial barrier to the improvement of health, education and standards of living. India faces the most acute challenge of electricity access in the world with about 1/3rd of its 246 million households still off the grid, which is one of the largest demographics globally. In addition, it has a very high population which is under-electrified and consuming less than 50 Kwh of electricity per month.

Kerosene: A Primary Source for Off- Grid Lighting

For un-electrified villages, kerosene is a primary source of lighting across various income groups. It has been estimated that the annual expenditure on kerosene for lighting by off-grid and under-electrified households is around USD 2.2 billion.² Out of this, around USD 1.8 billion is spent by rural households.

Figure 1: Expenditure on Kerosene by Rural Households

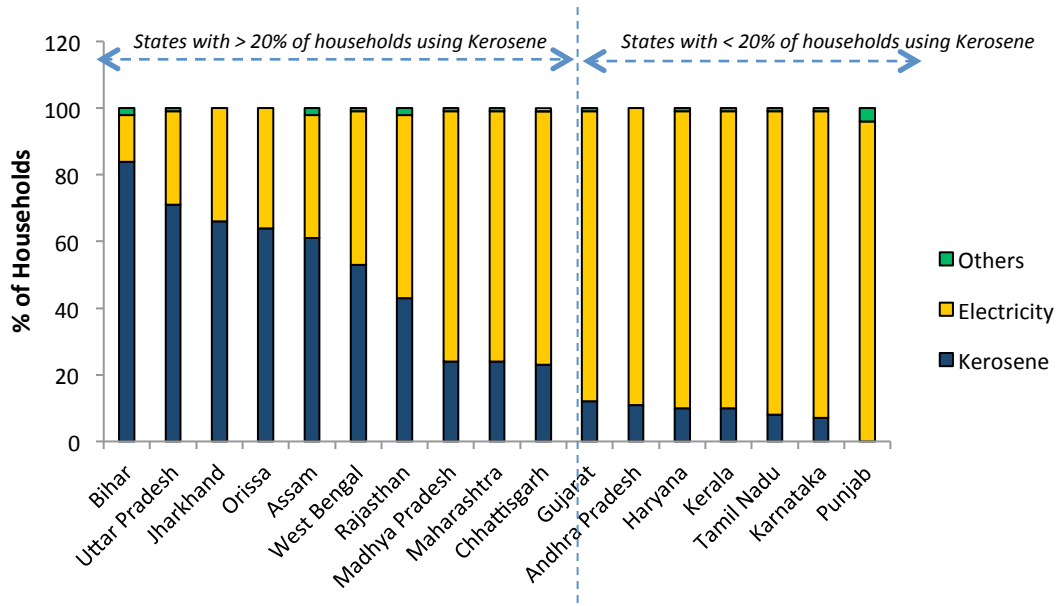


Among various states consuming kerosene for lighting, it has been analyzed that the seven low-income states, namely Bihar, Uttar Pradesh, Jharkhand, Orissa, Assam, West Bengal and Rajasthan are the most prominent consumers of kerosene. Villages in these states constitute around 66 percent of rural households in India.

¹ The SAP would like to thank Himanshu Verma from TERI for contributions to the India Case Study.

² Source: International Finance Corporation (IFC)

Figure 2: Primary Source of Lighting in Households Across States



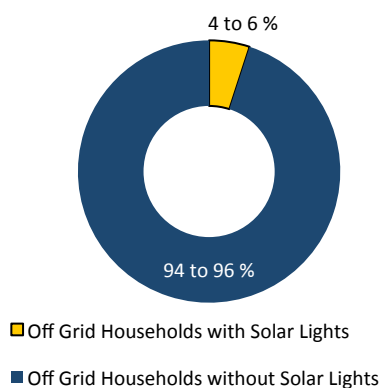
Source – Household Consumer Expenditures in India (NSSO) (2010), Intelicap analysis

Transition from Kerosene to Solar

In order to promote a sustainable solution for off-grid rural lighting, the government of India has adopted solar based lighting technologies. These were driven by the Ministry of New and Renewable Energy (MNRE), which is responsible for promoting Solar PV-based systems. However, as the market is gaining momentum, an increasing number of companies are entering into the market on a purely commercial basis. As a result an increasing number of rural households are adopting this new lighting technology. As per a report by International Finance Corporation (IFC), it has been estimated that around 2.5 to 3.5 million solar lanterns and around 1 million Solar Home Systems (SHS) have been disseminated in India. This implies that close to 3.5-4.5 million households are using solar based systems for lighting their houses. In the above mentioned figures of disseminated solar lights, The Energy and Resources Institute (TERI) through its “Lighting a Billion Lives (LaBL)” campaign has also contributed close to 450,000³ households. The total figure of 4 - 5 million, though significant, is a mere 5 to 6 percent of the off-grid household population of about 80 million in India.

³ Source: TERI’s Lighting a Billion Lives Campaign

Figure 3: Solar Lights Penetration Status as A Percentage of Off-Grid Households



It has been estimated that each off-grid household in India consumes around 3 litres of kerosene for lighting their house⁴. With a consideration that the government of India is subsidizing the consumption of first 3 litre of kerosene for lighting at the rate of INR (Indian currency of rupees; one USD is about 60 rupees) 32.87 per litre⁵, the government is spending close to INR 100 per household per month, which comes out to INR 1200 per household per annum for lighting by kerosene lamps. With close to 80 million households still using kerosene lamps, the actual spending on the subsidy for lighting kerosene lamps comes close to INR 100 billion per annum (all figures rounded).

One possible avenue for a transition can be to reroute the subsidy of kerosene into buying down of solar lanterns. As per the latest market scenario, it has been estimated that a high quality solar lantern costs around INR 2000. If the government were to route the current subsidy of INR 100 billion per year into the buying of solar lanterns then, theoretically, in a single year close to 50 million off-grid households could have solar-powered lanterns and in the next nine months the rest of the off-grid households could have access to solar lanterns. Therefore, in about 2 years, it is quite feasible to have a complete transition from kerosene to solar energy for lighting off grid households in India. A strong precedent exists in that Indonesia successfully completed a transition from subsidizing kerosene for cooking to instead subsidizing cleaner LPG for cooking. While not the ideal ultimate solution for the sake of climate, this example highlights the possibility to achieve a large-scale transition away from kerosene via redirection of government fuel subsidies.

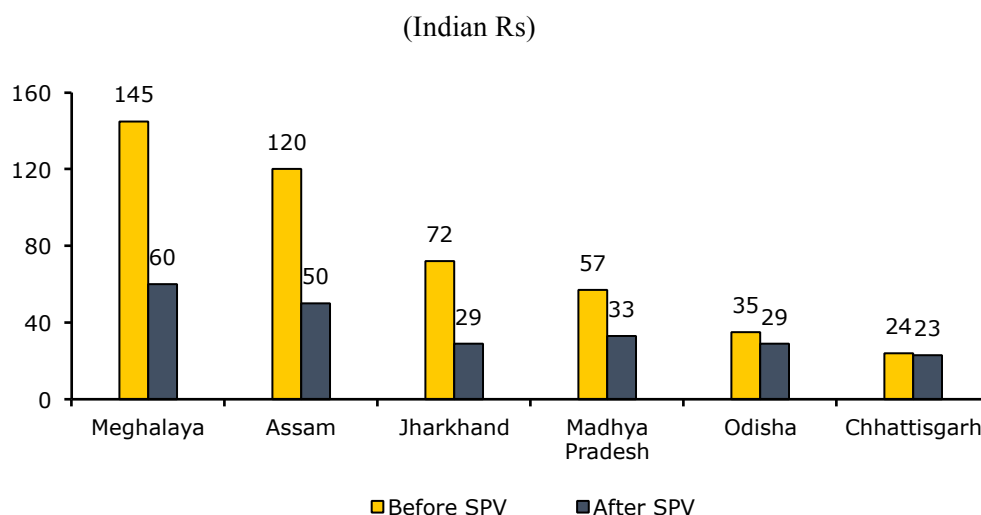
Impacts

Despite the fact that a lot of ground is yet to be covered by this new technology, penetration of lanterns and home lighting solutions powered by solar energy are creating substantial impacts in the lives of households which are deprived of clean lighting. A survey carried out by National Council of Applied Economic Research (NCAER) in six states, viz. Assam, Meghalaya, Jharkhand, Odisha, Madhya Pradesh, and Chhattisgarh, has revealed that with adoption of solar based lighting systems, the usage of kerosene for lighting is decreasing in rural areas. With reduced consumption of kerosene, the survey highlighted that, monthly expenditure on lighting has been reduced substantially after the adoption of solar based lighting solutions. The expenditure on lighting has been reduced by more than half in Meghalaya, Assam and Jharkhand. The complete details on monthly expenditure before and after installation of solar based lighting systems are furnished in figure 4.

⁴ Based upon the TERI's primary research of rural households

⁵ Source: Press Trust of India

Figure 4: Monthly Expenditure on Lighting Before & After Solar-Based Lighting Systems



Overall Recommendation for India

Among various alternatives in place to provide cleaner and better quality lighting services to the energy poor, one possible solution can be to re-assign the subsidy provided by the government of India for fuel for kerosene lamps towards decentralized solar or renewables based lighting solutions. Doing so holds the potential of facilitating a national transition to efficient lighting in less than two years.

2 - Africa

About 60% of Africans have no access to electricity compared with 25% in Asia. Approximately 580 million Africans (about 110 million households) live without electricity and depend on fuel based lamps. If current trends continue, Africa will be the only continent that will witness an increase its un-electrified population from the 110 million households in 2010 to 120 million households by 2015. Motivated by such stark statistics, the World Bank and the International Finance Corporation has launched the Lighting Africa program (Lighting Africa 2010) that will accelerate the development of off-grid solar-powered lighting systems (CFL and LED) to sub-Saharan Africa. By 2012, 2 million individual solar lamps (mostly LEDs) had been sold in Africa and the Lighting Africa program projects a sale of 11 million solar lamps by 2015 (Lighting Africa, 2012). While this is a major step forward, much more development work needs to be done to scale up to the 120 million un-electrified households.

TERI's Lighting a Billion Lives (LaBL) Campaign (Contd.)

The LaBL initiative is a commitment to bring safe, clean and affordable solar lighting to a billion people across the globe. The initiative provides villages that lack or have limited/unreliable energy access with the opportunity of benefiting from solar lighting services, through the dissemination of efficient and cost effective solar lanterns recharged from solar charging stations (SCS) in a 'fee-for-service, flexible-use' model or lighting services from fixed LEDs connected through a solar DC micro grid (SMG). This approach is being implemented on the basis of an entrepreneurial model of energy service delivery, especially targeting the base of pyramid population. Through this model, institutional mechanisms are being created for solar lighting services in villages where kerosene is the predominant fuel used for lighting not only in households but also in small enterprises such as shops, local bazaars and haats (markets), coaching centres etc. Further, the design of the model is such that it benefits the users as well as acting as a livelihood opportunity for the entrepreneurs of the services who rent the lanterns to villagers daily or provide the lighting service through fixed LEDs in lieu of a nominal daily or monthly fee. While lighting through the SCS model is seen to be predominately more appropriate for poor and remote communities, the SMG model is a clear preference for slightly better-off communities that can afford more than one light point. The technological options depend largely on the socio-economic conditions of the community that govern their demand for a particular option.

The initiative has now reached around 2580 villages across 23 states in India benefiting around 450,000 households through the use of a little over 100,000 solar lanterns. Whilst the primary objective of LaBL is focused towards ensuring that clean lighting is provided to rural communities, an equally important goal has been the development of a supply chain and service network capable of supporting the delivery of other energy services as well. Since its launch, LaBL has also fostered development and customization of new and improved versions of lanterns by bringing together the most reputed manufacturers of solar lanterns from across the country

