



KEROSENE TO SOLAR SWAP

Policy Brief #3

Sustainable Lighting Solutions for Homes in Rural India:

Achieving a transition from kerosene to off-grid solar for lighting

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Introduction

This policy brief analyzes the current policy environment governing kerosene and off-grid solar use. It sets out a suite of detailed policy interventions that can be implemented to achieve a systemic transition from kerosene to solar for lighting in rural India.

The paper is one of a series of three policy briefs examining the links between the use of kerosene fuel and off-grid solar applications for lighting in rural India. The papers provide initial policy solutions to enhance off-grid solar penetration by tackling the barriers to an enabling market environment for solar, while pursuing kerosene subsidy reform.

Policy Brief 1 (Garg et al., 2017) examines the existing system of kerosene subsidies in India, the key issues facing this system and the impact of kerosene subsidies on the uptake of clean, alternative off-grid solar lighting solutions. Policy Brief 2 (Jena & Natrajan, 2017) looks at the current market situation for off-grid solar technologies in India, and the current barriers to an enabling business environment for solar.

The Problems with Kerosene

The issues and challenges involved in kerosene use and kerosene subsidization in India are well documented (Climate and Clean Air Coalition, 2014; Gupta & Maithani, 2015). Extended kerosene use within households poses a range of health risks—indoor air pollution from kerosene use causes 500,000 premature deaths in India per year, while burns from kerosene are one of the leading causes of serious child injury (UNEP, 2014). Kerosene use limits the educational potential of children owing to poor-quality light produced and danger presented by naked flames. It also limits the income-generating potential of adults and contributes to greenhouse gas emissions and climate change.

Despite these issues, the Government of India (GoI) has long-maintained subsidies for the consumption of kerosene through India's Public Distribution System (PDS), with household allocations and eligibility criteria differing from state to state.

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In rural areas where grid connectivity is limited and/or the reliability of electricity supply is poor, kerosene is used mostly for lighting homes. However, India's system of kerosene subsidy distribution has deep flaws and structural problems of its own. It is estimated, for example, that close to 50 per cent of subsidized kerosene that is allocated to households is lost (or "leaked") in the process of distribution through theft, divergence and adulteration. All this at a significant cost to public finances (Clarke, 2014).

While kerosene use and the current system of kerosene subsidy distribution are highly problematic, where the penetration of grid electricity is limited (in particular rural areas) off-grid solar applications can effectively replace kerosene to light homes in rural areas. This leads to significant developmental and environmental benefits.

Small off-grid solar applications (including solar lanterns and solar home systems, or SHS) provide clean, reliable, powerful and increasingly cost-effective lighting to households. This policy brief examines ways in which government policy can promote solar lighting by encouraging kerosene subsidy reform, by tackling financial barriers and by using sophisticated emerging public and private-sector payment infrastructure.

Understanding the Barriers to Greater Off-Grid Solar Penetration

In India, there remain a number of barriers that are slowing down greater uptake of solar technologies. Key barriers include:

- The complexity of technical installation of SHS compared to kerosene lanterns
- Barriers to sales and service, such as a lack of retail outlets and service personnel (especially in rural areas, where they are most needed)
- Financial and subsidy-related barriers such as the relatively high upfront costs of solar systems compared to subsidized kerosene lighting.

This policy brief focuses on this final set of barriers, and will examine concrete, implementable ways in which these challenges can be tackled.

According to the Global Off-Grid Lighting Association (GOGLA), limited access to financing for companies and end users to purchase off-grid solar products is the most significant barrier to greater uptake of solar lighting.

At a global level, the cost of solar energy has decreased by around 6–8 per cent per year since 1998 (National Renewable Energy Laboratory, 2014). Despite this, high upfront cost and expensive finance means that, for many, kerosene remains the cheaper option. Subsidies effectively halve the cost of lighting with kerosene, driving the poorest households to continue to consume this inferior means of lighting.

The following sections of this brief describe the nature of these two barriers, before discussing ways to tackle them.

Financial Barriers

The primary financial barrier to solar lighting penetration is the high upfront cost of solar systems. Financial products are very often needed to assist with these upfront costs. They can help to spread payment over time and match the consumption of kerosene lighting. In India, these challenges are particularly apparent. This is due, in part, to a generally low level of consumer access to bank accounts and mobile payment technologies (largely historically), combined with slow-paced reform of regulatory barriers to banking sector innovation and to the provision of in-house finance for solar retailers.

The GoI has tried to tackle the challenge of high upfront costs partly through a provision of grants and subsidies. While these have helped thousands of households to purchase various solar applications, schemes like these have not reached the scale needed to enhance solar access for the millions that currently rely on kerosene to light their homes.

Microfinance institutions (MFIs) have also been an important sales channel for solar products, yet they have not proved to be a “silver bullet” in overcoming high upfront product costs. MFI interest rates tend to be high (typically 24–26 per cent), and evidence suggests MFIs have often experienced poor after-sales performance due, in turn, to poor product performance.

These financing issues have been compounded by lacking financial inclusion, particularly in poor and rural areas. In 2014, only half of India’s population of 1.3 billion had access to a household bank account, and recent surveys show only 15 per cent use bank accounts to make or receive payments (The Hindu, 2015). To address this, in August 2014 the GoI launched the Jan Dhan Yojana (JDY) scheme, with the goal of opening a bank account for every household. By November 2015, approximately 192 million bank accounts had been opened, however a large proportion of these have zero balances (The Hindu, 2015; Finance Ministry, 2015). While JDY has been a significant success, it will likely take some time for consumers to move from government-created bank account holders to active users of financial products. And for many households, access to basic banking services is simply not enough to overcome the financial barriers to purchasing and using solar systems.

To improve access to banking services, the Reserve Bank of India (RBI) recently issued 23 new banking licenses, with the aim of enhancing access to basic financial services and boosting competition and innovation across the Indian banking sector. Since April 2014, two licenses were issued for universal banks, 11 for payment banks and 10 for small finance banks (Financial Times, 2015; Business Standard, 2015). The payments license is particularly noteworthy, as it facilitates money transfers through mobile wallets. This move should include more rural poor consumers under some form of banking.

India Post is one of the organizations approved to start offering payment banking services, and with potentially transformative results for poor and rural areas, since it operates a vast network of 155,015 post offices (139,144 of which are in rural areas). These offices could be used to reach new and under-served customers already familiar with the postal service. Nevertheless, financial inclusion and literacy around basic financial services currently remains a significant challenge in India.

Pay As You Go and Mobile Money

Pay-as-you-go (PAYG) financing models, in which customers make an initial deposit followed by payments to keep the device operational, have significant potential to make solar lighting products in India more affordable, since that model spreads out the payment of upfront costs. PAYG is similar to other forms of debt, however certain risks are passed to the seller, as customers can discontinue payment more flexibly and do not pay for non-functional products. Mobile payments, supporting PAYG products, are collected electronically without the need for door-to-door debt collection. Mobile wallets are a technological enabler but are also subject to regulation.

PAYG payment models and products are still in their infancy in India. The ability to easily make payments is an important precondition for PAYG for small solar to succeed on a mass scale. While a raft of new mobile money providers has appeared in recent years (Airtel Money, Vodafone’s M-Pesa, Idea Cellular’s M-Wallet etc.), less money was reported to be transferred through the services in India than in Pakistan or Bangladesh in 2014. This may change

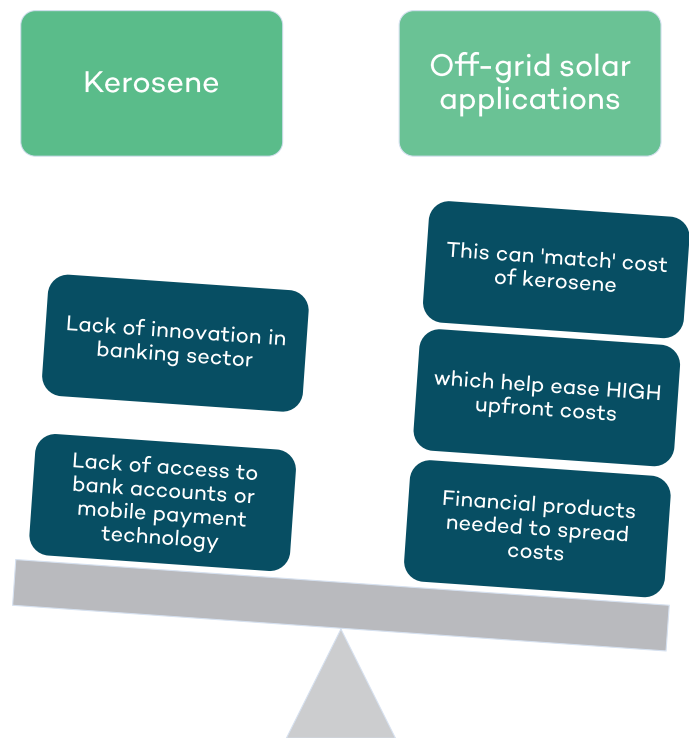


Figure 1. The bottleneck of financial inclusion



in the years to come, as both Airtel and M-Pesa have received payment licenses, which permits them to offer money withdrawal facilities to their customers for a small fee (The Hindu, 2017). However, there are other concerns about:

- Security
- Lack of access to telephone networks or the Internet
- Lack of trust or customer awareness
- Lack of willingness to adopt a technology driven by cultural differences
- Ongoing regulatory hurdles (Sinha, 2015; Verma & Singh Nehra, 2012)

In short, increasing the uptake of mobile banking will require an expansion of access to banking services in rural areas and measures to promote increased acceptance of banking to customers with low financial literacy. Established banks will also need to invest in the technology required to make payments more user-friendly. Initiatives like the 2020 digital transformation strategy at the State Bank of India show the willingness of public banks to increasingly make investments in this direction (Economic Times of India, 2015). And the new payment banks approved by the RBI, including India Post, are positioned to create partnerships with mobile operators to increasingly roll out mobile payments services. These institutions are often already backed by established players in mobile banking or telecoms (such as Vodafone), which has seen the success of its M-PESA system in a number of other countries.

Subsidy Barriers

Kerosene use is counterintuitive for households relying on it for lighting. Kerosene lamps are simple, and are inexpensive to purchase. In contrast to solar lighting, the cost of purchasing kerosene fuel is the huge majority of lighting costs. This means that, if variable household incomes fall, use can be suspended or reduced (replaced, for example, with candles) until income rises again. Importantly, poor households in rural parts of India are familiar and comfortable with the use of kerosene for lighting, and often discount the health risks that it poses.

Most importantly, by effectively halving the cost of lighting with kerosene, subsidies provide a major challenge to the competitiveness of solar lighting. As outlined in Policy Brief 1, the use of three litres of subsidized kerosene per month (allowing for nine lamp hours per night) for one year costs households INR 576 (USD 9.2) per year (Garg et al., 2017). In comparison, a mid-level solar lantern product with a lifetime of two years that provides nine hours of light per day will cost approximately INR 1,800 (USD 26), or 900 INR per year (USD 13) without financing costs. A high-end product with a life of two years that provides nine hours of lighting (as well as phone charging capacities) will cost INR 2,400 (USD 35), or 1,200 INR (USD 17) per year, without financing.

Bottom-of-the-pyramid (BOP) households tend to have very high discount rates on future savings, so payback periods must be short to be attractive. This is the key reason why upfront system costs are such an important barrier to greater uptake of solar systems. As such, kerosene subsidy reform is likely to be an important precondition for the large-scale uptake of solar lighting in India.

However, such reform is a difficult and sensitive task. It is often the poorest and most marginalized communities that rely on kerosene for lighting, and so it is a generally agreed principle that subsidy reform needs happen in a way that ensures that these communities are not “left in the dark.” Making solar lighting products affordable and available is therefore essential. The following section of this paper details current efforts undertaken by national and state government to rationalize and reform kerosene subsidies.

Reforming Kerosene Subsidies

Reducing Allocations

As discussed in Policy Brief 1, in lieu of removing kerosene subsidies, the GoI has historically reduced the size (and therefore cost) of kerosene subsidies allocated to states in line with growing wealth and increasing rural electrification (Garg et al., 2017).



Per-state PDS kerosene allocations are calculated by the Ministry of Petroleum and Natural Gas (MoPNG). Kerosene is released for delivery on a quarterly basis, with the Department of Food and Civil Supplies within each state responsible for ensuring uplift of quota allocation and distribution to retail outlets. In this supply chain, divergence, pilferage and adulteration of PDS kerosene are a challenge. A recent analysis of PDS allocations and household survey data estimated total PDS kerosene leakage to parallel markets to be approximately 45 per cent of total allocation, while an internal government assessment reported in August 2014 estimated that around 33 per cent of total supply was diverted to non-household use (Clarke, 2014).

To check leakage, the government has significantly decreased total annual PDS kerosene allocations in the period from FY 2009/10 onwards, with allocations falling by 7.9 per cent, 8.5 per cent and 4.2 per cent in 2011/12, 2012/13 and 2013/14 respectively.

Direct Benefit Transfer for Kerosene

Recently, the GoI has tightened the distribution of PDS kerosene through innovative measures linking subsidy receipt with eligible users. This cash transfer scheme for kerosene is based on the mechanisms used under the Direct Benefits Transfer for LPG (DBTL) scheme (also known as PAHAL). It is by far the largest of these schemes and indeed the largest cash transfer program in history.

Under DBTL, households order an LPG cylinder from their local LPG distributor, receive an amount equivalent to the current subsidy amount via electronic transfer to their bank account, then pay the full (unsubsidized) price for the cylinder in cash on delivery. The bank accounts of recipients are cross-checked with personal information, including current address (confirmed either through the recipient's Aadhaar identification details [see Box 1] or another form of government identification) to establish a linkage between the recipient and a registered, eligible LPG connection (or account). Connecting the subsidy receipt with the personal details and bank account of recipients makes the LPG subsidy system much more resilient against leakage and fraud. And in fact, the government has claimed that, since July 2016, 35 million fraudulent LPG connections have been removed from the subsidy system, saving the GoI around USD 3.3 billion (Times of India, 2016).

Box 1: What is Aadhaar?

Aadhaar offers a digitized, centralized technology infrastructure that allows for electronic identification and authentication of beneficiaries. Assuming Aadhaar holders have bank accounts, Aadhaar numbers can also be linked to these bank accounts; this linking process is rapidly underway as both Aadhaar enrolment and financial inclusion expand. The Aadhaar Payments Bridge (APB) is a repository of all these Aadhaar–bank account links to be used by various government agencies to send social security and entitlement payments to beneficiaries. At the same time, the GoI is in the process of rolling out the Aadhaar Enabled Payments System, under which Aadhaar holders can perform basic financial transactions through their bank-linked Aadhaar numbers at micro-kiosks around the country (UIDAI, 2016).

Together, Aadhaar and financial inclusion through JDY are creating a powerful new way for Indians to receive, access and spend social payments, as well as other financial products and services. The GoI therefore talks about the “JAM trinity”—the combination of JDY, Aadhaar and mobile payments—as the bright future of service, banking and product access in India.

The GoI has proposed implementing this same system for the subsidized goods distributed through the PDS, including kerosene (known as DBT-K), with pilot programs in four districts in the state of Jharkhand in 2016. More states are expected to roll out the scheme in 2017, though the results of the pilot have not been released.

In the same way as for LPG, households would purchase their allocation of kerosene from Fair Price Shops and then receive a cash transfer for the kerosene subsidy amount into their bank accounts, which are linked (“seeded”) to the Aadhaar cards or other government identification they present upon purchase. It is hoped that, by requiring the purchase of kerosene at market rates and then transferring the subsidy to linked bank accounts ex post facto, divergence will be reduced.



However, this program assumes that beneficiaries have access to, and are able to effectively use, basic banking services—a significant assumption given the geographic distribution and socioeconomic profiles of kerosene users. It also assumes a high level of digitization within the antiquated PDS system, such that digital beneficiary records exist and are electronically linked with bank account details. Given these issues, it will be some time before DBT-K is functioning effectively, with potential risks of beneficiary exclusion in the short term.

Leveraging the Emerging Aadhaar-Money Infrastructure

The Modi Government, elected in mid-2014, effectively accelerated innovation across the financial infrastructure. In particular, this has leveraged the effectiveness of the Aadhaar unique identification system as a tool for delivering social benefits. And in doing so, the government seeks to fundamentally change the way that subsidies and social programs are delivered in India. DBT-K is a new application of these principles, and DBTL is the most prominent example of this system in operation. By the end of 2016, Aadhaar had a penetration rate of close to 83 per cent of India's population.

The Difficulty of Kerosene Subsidy Removal

Putting aside the high risk of significant beneficiary exclusion in the short term, the GoI currently has the administrative capacity and infrastructure to deliver kerosene subsidies (and other social programs) electronically to beneficiaries' bank accounts as they consume the product. In doing so, it is hoped that the risk of leakage and divergence of PDS kerosene can be dramatically reduced. However, while this infrastructure allows subsidies to be distributed in a more targeted manner, it does not in itself remove kerosene subsidies altogether.

In the absence of easy, affordable access to new lighting substitutes, including grid electricity and solar lighting systems, policy-makers are largely bound to ensure that poor and rural households have access to kerosene for lighting. Until affordable supplies of other lighting technologies are guaranteed for BOP consumers, kerosene subsidies are likely to remain. In some ways, policy-makers therefore face a “chicken-and-egg” situation. On the one hand, the existence of kerosene subsidies directly constrains the development of the solar lighting market. However, on the other hand, kerosene subsidies are necessary in the absence of well-developed markets for affordable lighting substitutes for the poor.

The following section discusses ways and solutions to tackle this challenge.

Enabling a Large-Scale Transition from Kerosene to Solar

In recent years, the penetration of solar lighting has grown impressively in India. However, significant barriers to greater uptake remain and, for many households, all but the very simplest of solar lighting systems remain largely out of reach. So, how can policy stimulate a fundamental, economy-wide transition from kerosene to solar?

Policies must promote a transition from kerosene to solar without creating a gap that leaves BOP consumers without access to lighting. Measures that level the playing field for solar lighting can be divided into three groups:

1. Measures that create the enabling conditions to support the expansion of the solar lighting market
2. Measures that reduce the level and size of kerosene subsidies while increasing their targeting
3. Measures that directly address the immediate high upfront cost of solar lighting vis-à-vis kerosene, as described in Policy Brief 1 (Garg et al., 2017)

Together, the interventions detailed below can provide a comprehensive suite of policies that can be implemented by the Ministry of New and Renewable Energy and the Ministry of Finance over time to precipitate a large-scale transition from kerosene to off-grid solar for lighting in rural India.



Creating an Enabling Environment for Solar Lighting Market Development

As discussed, the business environment for off-grid solar is currently constrained by issues around solar costs and access to finance. On top of this, there are barriers around trust, awareness and political economics. To create an enabling environment for sustainable off-grid lighting and household electrification markets in India, a number of initiatives should be considered for implementation. These include:

- Establishing collaborative arrangements between the Ministry of New and Renewable Energy, trade associations and industry groups to identify and address regulatory barriers for solar producers, retailers and financiers, and to support new business models that offer reduced prices or expansion into new markets and anticipate policy roadblocks.
- Reviewing India's existing solar standards and accreditation frameworks and establishing internationally recognized accreditation norms for off-grid solar technologies that: a) work to reduce the cost of accreditation; b) streamline the accreditation process; and c) provide an appropriate trade-off between flexibility and quality assurance.
- Promoting greater public trust in solar technologies by requiring all accredited products to include appropriate warranties so as to transfer the technical risks of solar sales from consumers to manufacturers and distributors.
- Increasing focus on the importance of the GoI's financial inclusion programs. This will help ensure that bank accounts come with access to basic payment services, whether online, direct debit or via mobile. Access to these payment technologies will help to enable business models predicated on low-cost collection of regular payments.
- Enhancing access to financing options for the purchase and use of off-grid solar applications. Access to finance (for both consumers and solar enterprises) can also be enhanced by establishing district-level quotas or targets for loans made to off-grid solar applications by rural banks.
- Allowing for the sale of solar lighting equipment in Fair Price Shops so that revenues from the sale of solar products can slowly replace revenue from kerosene sales. In this model, Fair Price Shops could also act as the after-sales service providers and be the permanent, trusted link between customer and manufacturer.
- Raising awareness of the health risks associated with kerosene use and the benefits of solar products, for instance through school campaigns or public announcements.

Reforming and Reducing Kerosene Subsidies over Time

As greater solar penetration is achieved (providing an affordable lighting alternative at a mass scale across all parts of India) the GoI should gradually continue to reform and reduce kerosene subsidies. This will increasingly undermine subsidies' distortionary effect on the development of clean lighting alternatives over time. As discussed, this is a difficult process; however, it can be achieved gradually and inclusively.

Key aspects of this process include:

- Improving the effectiveness of kerosene subsidy distribution to reduce leakage and divergence through the DBT-K program, while being aware of the risk of beneficiary exclusion and monitoring the extent of this over time. The results of the DBT-K pilot in the state of Jharkhand have yet to be examined for improving the scheme's administrative efficiency.
- Reviewing eligibility criteria for kerosene subsidies to promote increasing targeting of subsidies. This is challenging given that eligibility criteria are set by state governments. However, it can be led by forceful advocacy from the GoI, as part of the process to roll out DBT-K from state to state. Cross learning from the fertilizer subsidy disbursement mechanism can help the DBT-K program evolve.
- Continuing a policy to gradually decrease the size of kerosene subsidies through continued year-on-year reductions of PDS kerosene allocations to states. Incentivizing the mechanism through cash incentives to states who uptake voluntary reductions has worked well.



- Implementing related initiatives in urban areas to replace kerosene use for cooking with LPG, through the expansion of Delhi-style Kerosene Free programs, and continued expansion of LPG access. Reducing the reliance of certain urban households on kerosene for cooking means government can undertake kerosene subsidy reform without the risk of depriving these households of cooking fuel.
- Continuing with the fortnightly kerosene price increases to close the cost gap between kerosene and entry-level solar lamps.

Addressing the High Upfront Costs of Solar Lighting

Despite rapidly falling production costs, the upfront cost of solar lighting systems remains a key barrier that is preventing kerosene from being replaced with solar energy.

Even with access to commercial and personal finance and PAYG products, solar lighting products remain expensive in comparison to kerosene, as set out in Policy Brief 1 (Garg et al., 2017), as well as in comparison to the wealth and incomes of typical kerosene users.

Every consumer that switches from kerosene to solar reduces the fiscal burden to the government of providing kerosene subsidies. To reflect this, a portion of kerosene subsidy savings resulting from the switch to solar could be used to fund programs that promote greater solar penetration, thereby creating a virtuous cycle of transition and market development.

In general, by reducing the kerosene subsidy burden, financial incentives that promote off-grid solar use are likely to be fiscally positive, and can be designed as such. The GoI currently provides a subsidy of around INR 600 (USD 9.5) per annum to each household using its allocation of PDS kerosene (not considering the cost of leakage and divergence). With the use of solar applications replacing the need for kerosene, this means that the GoI could provide assistance to households for the purchase and use of off-grid solar of up to INR 599 per annum and still save money. This offers a wide scope for financial assistance given the annualized cost of a mid-level solar lantern is approximately INR 900 (without financing costs).

Below are a number of options by which potential financial incentives that tackle the upfront cost of solar applications could be delivered:

1. **Results-based financing (RBF)** models could be deployed. Incentives for shops and distributors to promote solar could include offering monetary rewards to shop owners in areas with high off-grid populations for every customer they convince to switch to solar lighting. Results-based financing has been successfully employed in Tanzania to create incentives for companies to move into less well served areas. The challenge of an RBF system is the monitoring and verification process, as proof needs to be provided that customers were indeed added. The Aadhaar infrastructure, however, provides an effective way of achieving this.
2. **Direct subsidy payments** could be made directly to customers purchasing solar systems. Reflecting the government's enthusiasm for DBT, this could be built on the cutting-edge DBT payment infrastructure that now exists—a DBT for solar—which is delivered through Fair Price Shops (see above) and which tackles many of the problems experienced under previous grant systems. As with other DBT schemes, accredited private-sector vendors would be connected to the APB to link purchase with subsidy delivery. Customers purchasing solar systems would receive a one-off subsidy cash transfer of two sizes, depending on whether lanterns or home systems are bought.
3. **Supply side models** to reduce the cost of credit to the sector could be implemented. Low-cost finance for refinancing of solar system loans and working capital for solar enterprises could be made available to the sector. This would be similar to the IDCOL system in Bangladesh.

In Bangladesh, large-scale subsidies have been deployed to install 3 million solar home systems since 2003 (IDCOL, 2015). These have been delivered through cheap refinancing, working capital and grants to retailers. Replicating this level of penetration in the much larger Indian market will require rigorous policy that helps to address the barriers related to upfront solar costs. Funds could be redirected through MFIs, post offices, banks and distributors to reduce the overall cost of system ownership.



To assess the performance and feasibility of each of these options, it is recommended that a program of consultation and piloting is implemented. This will help build evidence for the eventual roll-out of a policy to tackle the high upfront costs of solar lighting.

Conclusions

- The widespread replacement of kerosene for lighting with off-grid solar technologies in India is currently constrained by a number of market barriers. These include:
 - a) The high upfront cost of solar applications
 - b) A lack of access to financial products that can address affordability issues
 - c) The persistent subsidization of kerosene
- The Modi Government has been highly successful in expanding access to basic financial services for poor households. However, the development and accessibility of BOP loan products and mobile and electronic payment services (which help to address upfront cost issues) need to be accelerated through government policy and more open financial regulation. This should work alongside a larger effort to create an enabling environment for greater solar penetration.
- An enabling business environment and kerosene subsidy reform will be critical to achieving greater penetration of off-grid solar in India over time. However, achieving an economy-wide replacement of kerosene with solar is likely to require the reform and enhancement of current incentive and subsidy schemes for off-grid solar lighting.
- Kerosene subsidy reform over time is important to the development of a level playing field for off-grid solar applications. However, this is a difficult and sensitive process. Steps could be taken to progress kerosene subsidy reform through effective implementation of DBT-K (and greater beneficiary targeting under this program), continued PDS kerosene allocation reductions and kerosene price reform.
- There are several possibilities to redirect savings from the displacement of kerosene subsidies to create a virtuous circle, by addressing upfront solar costs and gradually eroding the competitive advantage of kerosene. It is recommended that research is carried out on the political, economic and social feasibility of potential policies through pilot studies and consultations.



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