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POLICY BRIEF 3

Lighting homes in rural India with sustainable solutions:

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

This Policy Brief analyses the current policy environment governing kerosene and off-grid solar use and sets out a suite of detailed policy interventions that can be implemented to achieve a systemic transition from the use kerosene to solar for lighting in rural India. It 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, and providing 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[1].

1. THE PROBLEMS WITH KEROSENE

The issues and challenges involved in kerosene use and kerosene subsidisation in India are well documented (CCAC, 2014; Gupta and 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 constrains the educational potential of children as well as the income-generating potential of adults. It also contributes to greenhouse gas emissions and climate change. Policy brief 1 documents these impacts in more detail.

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 close to 50 per cent of subsidised kerosene that is allocated is lost in the process of distribution through theft, divergence and adulteration, at a significant cost to public finances (Clarke, 2014).

[1] Policy Brief 1 examines the existing system of kerosene subsidies in India, the key issues facing this system and the implications of kerosene subsidies for the dissemination of clean, alternative off-grid solar lighting solutions. Policy Brief 2 looks at the current market situation for off-grid solar technologies in India, and the current impediments to an enabling business environment for solar.

While kerosene use and the current system of kerosene subsidy distribution are highly problematic, off-grid solar applications can effectively replace kerosene to light homes in rural areas where the penetration of grid electricity is limited, with significant developmental and environmental benefits. Small off-grid solar applications (such as solar lanterns and solar home systems) provide clean, reliable, powerful and increasingly cost-effective lighting to households. This policy brief will examine 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.

2. UNDERSTANDING THE BARRIERS TO GREATER OFF-GRID SOLAR PENETRATION

There remain, however, a number of important barriers to greater uptake of solar technologies in India. Technical barriers including the complexity of installation compared to kerosene lanterns; barriers to sales and service such as the lack of retail outlets and service personnel, especially in rural areas where they are most needed; and financial and subsidy related barriers including the high relative costs of solar systems compared to subsidised kerosene lighting and the high upfront cost of solar systems.

This policy brief will focus 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), access to finance for companies and end users to purchase and use of off-grid solar products is the most significant barrier to greater uptake of solar lighting. High upfront cost and expensive finance mean that, for many, kerosene remains cheaper than solar energy. Subsidies effectively halve the cost of lighting with kerosene, driving the poorest and most price sensitive households to continue to consume this objectively inferior means of lighting. The following sections of this policy brief describe the nature of these two barriers, before discussing ways to tackle these.

a) Financial barriers

The primary financial barrier to solar lighting penetration is the high upfront cost of solar systems. Financial products are needed to assist with these upfront costs, by spreading them over time to match the consumption of lighting. These challenges are particularly marked in India in part due to, at least historically, a generally low level of consumer access to bank accounts and mobile payment technologies, combined with regulatory barriers to innovation in the banking sector and to the provision of in-house finance for solar retailers. Each of these is discussed in detail below.

The bottleneck of financial inclusion

MFI's are not achieving scale: Microfinance Institutions (MFI) have 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%) (Economic Times, 2012) and evidence suggests MFIs have often experienced poor after-sales performance due, in turn, to poor product performance.

Increasing Financial Inclusion and Financial Literacy: 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. While JDY has been a significant success, it will likely take some time for consumers to actively begin using a range of financial products. Further, simple access to basic banking services is not sufficient to overcome the financial barriers to purchase and use of solar energy systems, as literacy around basic financial services are required to make consumers aware of ways to access solar products.

Using India Post that can reach the remote customer: To increase access to banking services the Reserve Bank of India (RBI) recently issued India Post a banking license. This has the potential to be transformative for financial inclusion in poor and rural areas as India Post operates a vast network of 155,015 post offices (139,144of which are in rural areas). If specific financial instruments focused on solar can be developed by India Post, they have the capacity to increase access.

Allowing in-house financing: Indian financial system regulations prevent 'in-house' financing that would allow solar equipment suppliers to offer finance on their products without the involvement of a licensed bank. Till consumers get included in the formal banking system, in-housing finance can help these consumers' access solar products.

Pay As You Go and Mobile Money

Pay As You Go (PAYG) is a financing model in which customers make an initial deposit followed by payments. This model has a significant potential to enhance the affordability of solar lighting in India by spreading the payment of upfront costs for customers over time. Other benefits of PAYG are:

- It 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 payments have the potential to dramatically reduce the cost of collecting regular payments for solar systems.

PAYG payment models and products, however, are still in their infancy in India. While a raft of new mobile money providers have 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. The main reason for this are current regulations which, for example, require that payment operators work with banks to cash out digital money (Quartz, 2014). Other reasons to explain limited uptake include concerns about security, no access to telephone networks or the internet, lack of trust, customer awareness, willingness to adopt the technology driven by cultural differences and remaining regulatory hurdles (Sinha, 2015) (Verma and Nehra, 2012).

Enhancing uptake of mobile banking will require legislative reform to further reduce barriers to mobile payment technology and financial literacy. Established banks will also need to invest in the technology needed to make payments 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).

Further, 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. Indeed, 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.

b) Subsidy barriers

The table below highlights some of the reasons why households prefer Kerosene for lighting.

Kerosene Lamps	Solar Lamps
Simple to use, inexpensive to purchase	High Upfront cost, require awareness to use
If household income falls, temporary suspension or reduction of kerosene purchase or replacement by candles	Lamps have a life of 2 years and will require maintenance and repair of battery/parts
Subsidized kerosene costs Rs 576 per year (Rs 1,152 for two years)[2]	A mid-level solar lantern product, with a lifetime of 2 years, will cost approximately INR 1800 (with no financial assistance)
Poor households often discount the health risks that kerosene use involves	More time spent on education by children or on income generating opportunities by adults

As such, the reform of kerosene subsidies is likely to be an important precondition for large-scale uptake of solar lighting systems in India. Making solar lighting products affordable and available is therefore essential. The following section of this paper details current efforts, undertaken by national and state governments, to rationalize and reform kerosene subsidies.

3. REFORMING KEROSENE SUBSIDIES

Reforming kerosene subsidies, is a difficult and sensitive task. It is often the poorest and most marginalized communities who rely on kerosene for lighting. It is a generally agreed principle that kerosene subsidy reform needs to take place in a way that ensures that these communities are not 'left in the dark'. The following discusses different approaches on kerosene subsidy reform.

a) Reducing allocations and increasing prices

The GoI has historically reduced the size (and therefore cost) of kerosene subsidies allocated to states. Reduced allocation has worked to reduce subsidy expenditure. Total annual PDS kerosene allocations have decreased significantly in the period from fiscal year (FY) 2009-10 onwards, with allocations falling by 7.9 per cent, 8.5 per cent and 4.2 percent in 2011-12, 2012-13 and 2013-14 respectively.

Recently the Ministry of Petroleum and Natural Gas announced monthly price increments of Rs 0.25 to the retail price of kerosene. The price hikes will begin from 1 July and continue till

[2] Assuming the use of three litres of subsidized kerosene per month (allowing for 9 lamp hours per night). In comparison, a mid-level solar lantern product will also provide nine hours of light per day.

March 2017 (Economic Times, 2016). However, divergence, pilferage and adulteration of PDS kerosene has, too, not been significantly affected. 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).

b) Direct Benefit Transfer for Kerosene

Recently, the Government has sought to further tighten the distribution of PDS kerosene through innovative measures designed to link subsidy receipt with eligible users, based on the mechanisms used under the Direct Benefits Transfer for LPG (DBTL) scheme (also known as PAHAL). DBTL is one of around 40 other direct benefit transfer (DBT) schemes, however is by far the largest of these – indeed, it is the largest cash transfer program in history.

Under DBTL, the connection of subsidy receipt with the personal details and bank account of recipients makes the system of LPG subsidy system much more resilient against leakage and fraud. The GoI has proposed implementing the same system of direct benefits transfer for the subsidized goods distributed through the PDS, including kerosene (known as DBT-K), with pilot programs set to begin soon. 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[3], 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*, the possibility and incentive for divergence will be undermined. This program, however, assumes that beneficiaries have access to, and are able to effectively use, basic banking services – a significant assumption given the geographic distribution and socio-economic profile 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 likely take some time for DBT-K to function effectively, with potential risks of beneficiary exclusion in the short-term.

c) Leveraging the emerging Aadhaar-money infrastructure

By end-2015, about 1 billion people had Aadhaar numbers, a penetration rate of close to 80 per cent of India's population. Aadhaar offers a digitized, centralised technology infrastructure that allows for electronic identification and authentication of beneficiaries. Assuming Aadhaar holders have bank accounts, Aadhaar number can, as discussed, also be linked to these bank accounts – a linking process which is rapidly underway as both Aadhaar enrolment and financial inclusion expands. The Aadhaar Payments Bridge (APB) is a repository of all these Aadhaar-bank account links, which is will 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

[3] The first transaction will be an advance to enable the household to purchase the kerosene and protect them from any cash flow problems (similar to LPG)

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.

ENABLING A LARGE-SCALE TRANSITION FROM KEROSENE TO SOLAR

The uptake and penetration of solar lighting has grown impressively in India in recent years. However significant barriers to greater uptake remain and, for many households, 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, a revolution in the way people light their homes?

Policies must promote a transition from kerosene to solar without creating a gap that leaves BOP consumers without access to lighting. In a way that kerosene is displaced as solar lighting becomes more attractive, affordable and available. Measures that 'level the playing field' for solar lighting can be divided into three groups –

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

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

a) Create an enabling environment for solar lighting market development

The business environment for off-grid solar is currently constrained by issues around solar costs and access to finance, as well as certain trust, awareness and political economy barriers. 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 by policymakers, including:

- The establishment of collaborative arrangements between MNRE and 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.

- The review of India's existing solar standards and accreditation frameworks and the establishment of internationally recognized accreditation norms for off-grid solar technologies that work to reduce the cost of accreditation, streamline the accreditation process and 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.

- Increasingly focus the emphasis of the GoI's financial inclusion programs to ensure bank accounts come with access to basic payments 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 by relaxing the restrictions on the provision of in-house financing for solar retailers and distributors that meet established criteria. 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.

- Raise awareness of the health risks associated with kerosene use and the benefits of solar products, for instance through school campaigns or public announcements.

b) Reforming 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 kerosene subsidies. This will reduce their 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 by effectively implementing the DBT-K program, while being aware of the risk of beneficiary exclusion and monitoring the extent of this over time.

- Review eligibility criteria for kerosene subsidies to promote increasing accurate targeting of subsidies. This is challenging given that state governments set eligibility criteria.

- Continuation of policy to gradually decrease the size of kerosene subsidies through continued year-on-year reductions of PDS kerosene allocations to states; in correspondence to electrification rates or other lighting solutions.

- Related initiatives to replace kerosene use for cooking with LPG, through the expansion of Delhi-style Kerosene Free programs, and continued expansion of LPG access in rural areas. Reducing the reliance of certain households on kerosene for cooking means government can undertake kerosene subsidy reform without the risk of depriving these households of cooking fuel.

c) Addressing the high upfront costs of solar lighting

Solar lighting products remain expensive in comparison to kerosene, as set out in Policy Brief 1, as well as in comparison to the incomes of kerosene consumers. But 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.

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 – a wide scope for financial assistance given the annualized cost of a mid-level solar lantern is approximately INR 900 (without financing costs).

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

1. **Results based financing** 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. 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 means by which to achieve 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 direct benefits transfer 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 Aadhaar Payments Bridge to establish the link between purchase and 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 in a similar manner to the IDCOL system in Bangladesh. In Bangladesh, large scale subsidies have been deployed, in the form of cheap refinancing, working capital and grants to retailers, to install about 3 million solar home systems since 2003 (IDCOL, 2015). Replicating this level of penetration in the much larger Indian market will require concerted policy that helps to address the barriers related to upfront solar costs. Funds could be redirected through MFIs, post offices, banks, and distributers to reduce the overall cost of system ownership.

To assess the performance and feasibility of each of these options it is proposed to embark on a program of consultation and piloting to build evidence for the eventual roll-out of a policy to tackle high upfront costs of solar lighting.

CONCLUSIONS

This policy brief 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 following section summarizes the discussion from all the three policy briefs.

KEROSENE SUBSIDY REFORMS

Kerosene Subsidy Reduces the Cost Competitiveness of Off-Grid Solar: Policy Brief 1 demonstrated a clear linkage between kerosene subsidy reform and the cost competitiveness of off-grid solar alternatives. Detailed calculations in that policy brief reveal that at the current level of kerosene subsidies, household expenditure on entry-level solar lighting system is only marginally lower than that on kerosene.

Improve Distribution of Kerosene Subsidies: 45% of the kerosene is lost to the black market. To reduce leakages, the central government is moving towards direct benefits transfer for most welfare schemes. By effectively implementing a direct benefit transfer program for kerosene, while being aware of the risk of beneficiary exclusion of this payments model, the government can improve the effectiveness of kerosene subsidy distribution so as to reduce leakage and divergence.

Improve Targeting of Kerosene Subsidies: The Economic Survey 2015-16 estimates that nearly 50% of the kerosene is consumed by the well off. Some state governments have experimented with eligibility criteria (for e.g. those who do not have LPG connections or are BPL (below poverty line) households etc.) to restrict beneficiaries of kerosene subsidies. By restricting kerosene subsidies to poor households, the real beneficiaries can be reached.

States can accelerate Kerosene Reform by Implementing DBT-K: 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 can be taken, however, 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 reforms.

SOLAR PROMOTION POLCIES

Build Trust in the Sector: to build trust in the solar sector, enforce quality assurance frameworks and after-sales obligations for solar products and providers. Also for further solar sector promotion, there should be limitation of the use of the mass distribution of near-zero cost and highly subsidized solar lanterns

Policies to improve Product Supply: Policies that can aid in relaxation of restrictions on the provision of in-house financing for select, authorised off-grid solar providers so that credit for solar applications becomes more widely available

Supply Side Policies: Consideration of simple fiscal mechanisms to reduce the costs of solar units, such as VAT and tariff exemptions; For example Solar products are exempted from these various duties in only in few states such as Andhra Pradesh, Maharashtra, Uttarakhand and Uttar Pradesh

FINANCIAL ACCESS & AFFORDABILITY	
	Ensure Access and Affordability of Solar Products: off-grid solar technologies have high up-front costs. Financial products can address these affordability issues. The development and accessibility of BOP loan products and mobile and electronic payments services – that help to address upfront cost issues – needs to accelerated through government policy and more open financial regulation, as part of a larger effort towards creating an enabling environment for greater solar penetration.
	Reaching the most remote consumer: India Post has recently been given a banking license. Since India Post has a vast network and the ability to reach the remotest consumers, it can create solar specific financial products to help consumers with the upfront costs.
	Using mobile money to increase financial access: Given high mobile network penetration in India, 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 can be linked with the aadhaar payment system to ensure seamless identification of the beneficiary and transfer of payments.
	Increasing Financial Literacy: Consumers have to be encouraged and made aware about solar products, their benefits and cost advantages over the long run. This requires awareness building programs about financial products to help with the high up front costs and further a willingness to transit from kerosene to solar. Awareness can help create a consumer demand for both financial and solar products.

Lastly, the uptake of solar can be understood and encouraged through small pilot studies. 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. Further research on the political economic and social feasibility of potential policies through pilot studies and consultation with states/district governments can help in identifying the challenges.

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