Financing for Whom by Whom? Complexities of Advancing Energy Access in India

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Abstract

About a quarter of India's population still lives without access to modern electricity. The majority of these people live in rural, remote areas which cannot be easily connected to the central grid. Supplying those without power and supplementing the intermittent electricity provision of those who are connected has become a central goal of the government. In working to achieve this goal, India has become a laboratory for innovative energy systems as well as finance structures that enable customers to gain access to these systems. By exploring case studies of different financing structures as well as interviewing solar technology business owners, I find that end-user financing (i.e. consumer subsidies and tax rebates) is relatively ineffective at enhancing sales of off-grid solar technologies. End-user financing relies on formal banking systems and hinders firms from passing on subsidized costs because of extenuated bureaucratic cost recovery. Alternatively, innovative financing structures, such as pay-as-you-go (PAYG) systems, crowdfunding, and different types of support for private companies and entrepreneurs have all shown promise to provide adaptable and timely support. If the government is to make meaningful progress toward its national goal to extend a constant supply of electricity to every household in the coming years, it will need to learn from and adapt its current financing structures for off-grid solar (and other renewable energy) technologies.

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Contents

1 Introduction

Financing energy access[1] for the rural poor presents many challenges. India has a population of 1.3 billion people, and about 275 million still lack access to electricity. Electricity access has increased significantly in India over the past 20 years, rising from 51 percent in 1990 to 79 percent in 2012. Overall, this increase is encouraging, but there is a drastic divide between urban and rural access gains. Rural areas increased access from 39 percent to 70 percent from 1990 to 2012, while urban areas currently have nearly universal access.[2] Reaching rural areas will be the major focus of current government. This approach raises several interesting questions related to financing for unconventional electricity access technologies, given that grid expansion will be prohibitively expensive and ineffective at delivering reliable electricity in many areas. Distributed solar energy systems—or micro-grids and mini-grids[3]—have demonstrated promise in providing locally generated and renewable power to households.

Decentralized solar power systems provide electricity to otherwise disconnected villages and households in addition to supplementing households with intermittent service, and investing in this form of energy is also in line with the government's goals to provide around-the-clock electricity to all Indian households by 2019 and install a staggering 100 gigawatts (GW) or solar energy by 2022. Initial adoption of solar technologies relied heavily on government-supported subsidies due to high upfront costs during early stages of development. If India is to meet its solar capacity and energy access targets, the government will continue to rely on traditional end-user financing (e.g. as has been used for kerosene consumption), but is also poised to invest in innovative financing for decentralized solar technologies. This paper will address the benefits and drawbacks of both types of financing, and which financing models should be applied in specific contexts. Over time, the cost of manufacturing solar technologies has steadily declined and the incomes of hundreds of millions of rural poor have risen. These changes have supported and will continue to enable breakthroughs in financing innovations from emerging off-grid solar energy enterprises that put these technologies within reach of the rural poor. This dichotomy of financing has led government policies to focus on end-user financing while remaining risk-averse to more creative financing. Indeed, the relatively high upfront cost of the technology has prevented its large-scale diffusion; however, field observations and experiments of business models employing

[1] There is no widely accepted definition for energy access, but as I will employ the term for the purposes of this study, energy access is simply having the ability to use at least a minimum amount of modern electricity (i.e. excluding traditional forms of energy, such as biomass) to conduct daily activities. http:// www.worldenergyoutlook.org/resources/energydevelopment/definingandmodellingenergyaccess/

[2] Figures for access to electricity were calculated by using the World Bank's "Access to electricity" data and "Population" data.

[3] India's Ministry of New and Renewable Energy (MNRE) defines micro-grids and mini-grids as standalone energy generation systems which rely on renewable supplies of energy to transmit electricity to consumers. Micro-grids and mini-grids are very similar, except that micro-grids have a generation capacity of less than 10 kilowatts (KW) and mini-grids have a capacity greater than 10 KW. http://mnre.gov.in/file-manager/UserFiles/draft-national-Mini_Micro-Grid-Policy.pdf

innovative financial tools in places like India should help identify where the emphasis should be for financing off-grid solar technologies moving forward.

Academic literature on decentralized energy access primarily focuses on traditional end-user finance, such as government subsidies described above. Recently, gray literature has begun to uncover the financing needs of energy access firms as being one of the barriers to off-grid technology diffusion (UN 2015; BNEF 2016). Due to emerging evidence about the lack of effectiveness of government subsidies, this study will explore the realities of funding for both end-user and firms operating in this sector. In particular, I will examine alternative approaches to government financing to help address both the ability and purchasing decision of end-users to pay for off-grid solar technologies. In section 2, I will present background information and India's political context, and then in section 3, I will discuss relevant literature on distributed energy financing. In section 4, I will explain the methodology for this study, followed by a discussion of the results in section 5 and the conclusions and policy implications in section 6.

2 Background and Political Context in India

To adequately discuss financing for off-grid solar technologies in India, one must examine the politics and policies of supplying energy in India, the complexities around financing off-grid solar energy access, and how innovations in financing energy access are surmounting the challenges that plague the sector.

2.1 The Politics and Policies of Energy Supply in India

India has a vast and complicated history of electrification policies. Of particular importance to this study, the 2006 Rural Electrification Policy established a "minimum supply"[4] of 1 kilowatt-hour (kWh) per household per day (364 kWh/household/year) "as a necessity by 2012" (MOP 2006). The Rural Electrification Policy additionally provided assurance of reliable power supply at reasonable rates and access to electricity for all households by 2009. Unfortunately, these goals were not fully realized due to inadequate investment in energy infrastructure, coupled with subsidies that had a crippling effect on the State Electricity Boards.[5]

Traditional end-user financing for energy access has largely come from the government. Under its National Solar Mission, the Indian government established a program to subsidize solar home lighting systems (SHS). The Indian Renewable Energy Development Agency (IREDA) through the National Bank for Agriculture and Rural Development (NABARD) implements the program. Only individuals, Self Help Groups (SHGs), Joint Liability Groups

[4] The minimum supply is calculated as the "lifeline requirement" corresponding to all of India's monthly per capita consumption of kerosene (0.61 liters) and electricity (6.35 kWh) for lighting.

[5] In India, the states manage their own generation, transmission, and distribution of electricity, which makes power planning particularly difficult to implement. Private power purchase agreements must be made separately with each state if one state or entity is to purchase power that crosses through multiple territories.

(JLGs) Non-Governmental Organizations (NGOs) and farmers' clubs are eligible for the subsidies. Forty percent of the cost of a SHS is subsidized and the remaining 60 percent of the cost is eligible for a soft loan through a registered bank. The Reserve Bank of India regulates all interest rates and margins for which the beneficiary is liable over the five-year loan repayment period. During those five years, the supplier of the technology (which is also authorized by the government) is required to provide after-sales support and maintenance service to the customer. The steps to apply for the subsidy are as follows: 1) open an account with a registered commercial or regional bank; 2) approach a vendor of SHS and agree to purchase a product; 3) submit all documents to the bank; 4) have the bank verify all documents and do a site survey to the home of the applicant; 5) have the bank submit documentation to NABARD for release of the subsidy to the bank; 6) have NABARD release the subsidy to bank; and 7) have the bank approve the loan and the customer receives the product from the vendor. This process is cumbersome; more recently, there have also been significant delays in the releasing of subsidies by NABARD.

The well-intentioned pro-poor policies designed to expand energy access resulted in a system of untargeted and wasteful producer and consumer subsides, which in turn resulted in the power sector's inability to generate enough revenue for continued investment in infrastructure and management expertise (Modi 2005). Failure to meet the original goals culminated in resetting the goals and continuing to expand the grid under the new Rajiv Gandhi Village Electrification Program (RGVEP), which was part of the National Common Minimum program of the ruling coalition at the time (United Progressive Alliance). Through the RGVEP, the ruling government claimed to have met its target of electrifying 100,000 villages and providing free electricity to 175,000 households below the poverty line by 2012.

India's struggle to meet its electricity demand nationally has resulted in inadequate service of electricity to even those villages that have unreliable access to the grid. As mentioned before, one of the interesting caveats in the government's electrification program, for example, is that only 10 percent of the households in the village need to be connected to the grid for the entire village to be considered electrified. This glaring case of conflicting political goals and realities of implementation of policy could, theoretically, render the entire country "electrified," but 200-300 million people will still be without access to power (REC 2005). The National Democratic Alliance (NDA) elected government that swept into power in May 2014 has redoubled the previous government's electrification efforts to achieve universal electrification by 2019, supported by both centralized and decentralized energy distribution systems. Of course, there will need to be enough power generated to ensure that the electricity supplied is adequate and reliable. To that end, the current government has made steady progress in tracking electrification efforts through its new online portal[6] and

[6] The "Garv Dashboard" can be found on the Ministry of Power's website (https://garv.gov.in/garv2/dashboard/garv).

improved reliability of power by increasing the overall power generation capacity in the country.[7]

2.1.1 Energy Pricing and Subsidies

A full review of energy pricing and subsidies is beyond the scope of this study; however, I will briefly discuss relevant elements of pricing and subsidization within this section, given the interconnectedness with innovative financing models. Specifically, "a standard collective action problem prevents politicians from making difficult decisions concerning electricity pricing" (Joseph 2010). The situation is so dire that a third of the country's electricity each year is not billed, and this may be attributed to electoral politics (Min 2014). Today, subsidized electricity and access at large is part of the nation's vote bank politics.[8] One example of this phenomenon is India's longstanding provision of subsidized electricity to farmers to irrigate their fields, a practice that led rural electrification efforts in the post-independence era. As nearly half of farmers' annual income may pay for diesel for irrigation pumping, subsidies to provide nearly free electricity were perceived as a means to alleviate an otherwise prohibitive financial burden in return for political allegiance. To quantify "nearly free," according to Cust et al., "typically grid tariffs for poor rural households range from Rs.0-10 ($0.16)/month for the poorest households[9] and Rs.0-130 ($2.05)/month for remaining domestic customers" (2007). To further complicate the matter for a financially strained system, where collection is undertaken, metering can often be faulty, and the frequency of collection may be just as erratic as the electricity supply. This system of subsidization and inefficient financial collection threatens India's already overburdened energy infrastructure.

Electoral politics makes it very cumbersome for any political party to reform subsidies that have been locked in place for decades. Furthermore, politicians have often meddled in electrification policies at the state level, which has led to uneven progress of electrification across the country. Take for example the rise of the Aam Aadmi Party (AAP) in Delhi, which won with an overwhelming majority of seats in the Legislative Assembly in 2014 on the promise of reductions in electricity prices. Another example comes from research conducted by Min and Golden (2014), which analyzed four decades of annual data from the power corporation of Uttar Pradesh, India's most populous and politically important state. Just before state assembly elections in 2002 and 2007, tremendous line losses occurred in certain localities where the incumbent party may have directed power at flat and unbilled rates (essentially discounted or free electricity) to gain an advantage. It could be argued, as pointed out by the struggles of off-grid solar enterprises operating in the state, that such practices create an ecosystem in which the population does not care to pay for electricity, no

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[7] Since March 2014, India has added 60 GW of capacity addition in conventional power and become a net exporter of electricity to nearby nations (Ministry of Power records 2017).

[8] Vote bank: consists of a loyal bloc of voters from a single community (often based on caste, religion or culture), who consistently support a certain candidate or political party in democratic elections.

[9] The central government funded Kutir Jyoti program aims to provide free basic connections for all BPL households. For non-BPL households, grid connections can be effectively free given poor rates of bill collection in many regions.

matter the cost, when they have known it to be free of charge. This government behavior violates one of Douglas Barnes's four principles of electrification, which specifically includes keeping politics separate from electrification projects (2007).[10]

Finally, subsidized kerosene creates yet another distortion. In this regard, rationing, a concept that was introduced in India during the 1940s at the time of the Bengal Famine, continues to pose a political challenge. The Public Distribution System (PDS) set up by the government provides basic consumption goods (primarily food grains but also kerosene) through local distributors (called "Fair Price Shops") at fixed government subsidized rates to all families classified as being below the (national) poverty line (BPL)—families earning less than $1/day. Households must carry a ration card in order to obtain these goods at subsidized rates from those shops. For example, each family might be able to receive a monthly supply of three to four liters of kerosene for their lighting and cooking needs for free or at a reduced rate. It is very difficult to get people to forego these subsidies once they rise above the poverty line; there may also be lack of adequate reporting in income in a "race to the bottom" to be able to get on the register for BPL benefits, particularly for cooking fuels (IE 2015). It is estimated that since 2008, the government spent approximately 1.4 percent of GDP subsidizing fossil fuels annually (Clarke 2014). Furthermore, subsidies for electricity along with technical and commercial losses account for 2.5 percent of India's GDP each year (Garg 2016).

The government began subsidizing kerosene to enable poorer households to purchase essential cooking fuel. However, recent findings reveal that kerosene is largely being used as a lighting fuel across the country. In some states, such as Bihar, 73 percent of rural households using the fuel solely for lighting (Singh 2015). Central subsidies for both electricity and kerosene can be augmented with state subsidies, and tend to price out viable decentralized renewable energy alternatives (such as solar home lighting systems), which are attempting to enter the large base of the pyramid market. Thus, rationing in favor of a particular energy option unintentionally inhibits the generation of adequate demand for these alternatives.[11]

3 Literature Review

To evaluate the changing dynamics of financing for energy access one needs to examine: 1) the role of customers' changing ability and decision to pay for off-grid technologies; 2) the declining costs of technologies; and 3) the financing needs of energy access firms today. I

[10] Barnes' five principles of electrification include: sustained government commitment, effective prioritization and planning (includes establishing a rural electrification body, coordinating with other rural development goals, limiting political interference, and reducing construction and operating costs), sustainable financing (includes developing effective subsidies), and having a customer focus by effective distribution companies.

[11] Heavy critique of kerosene-specific subsidies for lighting has prompted the government to recently launch the "Direct Benefit Transfer" program. This program provides a direct cash transfer to each household below the poverty line to purchase energy. By remaining agnostic to the type of technology adopted, it may encourage demand for alternative forms of energy, perhaps favoring solar home lighting solutions over kerosene.

present evidence from literature concerning consumers' willingness to pay as well as declining costs in sub-section 3.1 below since these two variables are complementary. I then explore financing needs of firms in sub-section 3.2.

3.1 Changing Dynamics: Financing Off-Grid Solar Energy Access

Pode (2013) argues that "the high upfront cost of SHSs [and the absence of payment flexibility] is deterring the penetration [of the technology] into [a] larger market of lower-income [rural populations]." However, studies specific to innovations not related to physical products, such as new financing models, claim that success is more likely when innovations are adapted to the user's cash cycle and economic situation (Monroy 2008, Bardouille 2012). Another study by Urmee and Harries (2009) evaluated numerous renewable energy implementers across the Asia Pacific region, including India, and suggests that the "lack of suitable financing mechanisms" is the most significant barrier to the uptake of solar home lighting systems. Furthermore, the study concluded that income is "no longer perceived to be the primary, or even a major, barrier to the uptake of solar home lighting systems."

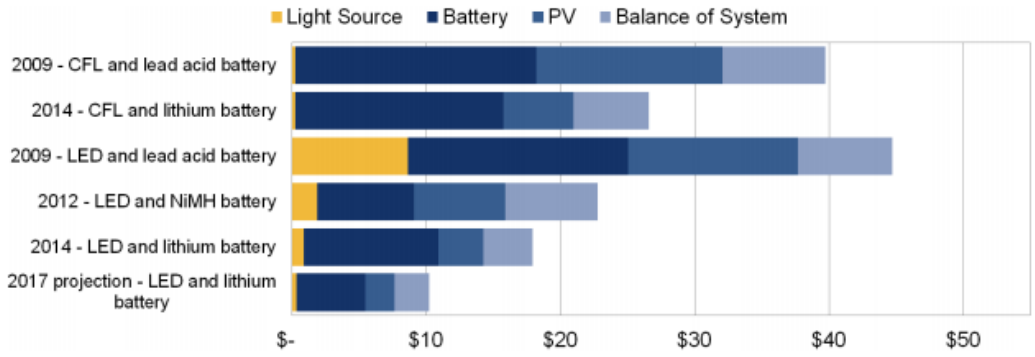
Other signs that the solar industry in India is less dependent on end-user income are apparent in Harish's (2013) study, which concludes that most providers of off-grid solar technologies in India use micro-finance institutions as a distribution channel for their products, not as a provider of credit. While the same study states that the "presence of willing banking partners was crucial to entering a new region," anecdotal evidence coupled with survey results show that the majority of off-grid solar enterprises are not using bank financing for the sales of their products. The story here may be that the role of banks may be critical in regions where populations have limited exposure to or awareness about off-grid solar technologies, such that it influences purchasing decisions. Perhaps, beyond a certain stage of technology penetration in an area, a firm can conduct sales with greater ease without the help of banks because the local population is familiar with the technology and its associated benefits. This would support the theory of diffusion of innovations presented by Rogers (2003), in which the experience of early adopters creates awareness amongst the local population and affects the overall rate of adoption (and, in this case, the decision to pay) for the innovation.

The findings of other researchers discussed above are also supported by a recent study of willingness to pay conducted by Urpelainen and Yoon (2015) among 750 households in rural areas of the north Indian state of Uttar Pradesh. The study found that households with high levels of awareness (or knowing someone who has a solar home lighting system) have an increased willingness to pay for such systems. As expected, the study found that households which had access to the grid or high levels of income also had a higher willingness to pay. Overall, the study concluded that there was a Rs. 3000 ($50) gap between the respondents' willingness to pay and the actual cost of a high-quality 40-Watt SHS in the market. This gap is arguably marginal; given the availability of financing innovations employed by a firm, it could easily be bridged to facilitate the purchase of such systems on a larger scale.

The sharp decline in the cost of solar PV panels driven by manufacturing in China (Aanesen 2012) coupled with domestic government policies, such as the National Solar Mission, have

supported "the emergence of new solar lighting firms targeting rural customers" (Harish 2013). These firms are capable of improving business models that provide access to previously cost-prohibitive solar technologies that are now much more affordable. Reduced costs for PV modules have been accompanied by improved demand-side efficiency (e.g. LED-based lighting). Harish et al. calculate that a system with three compact fluorescent lights powered with a 40-Watt panel and a 40 ampere hour (Ah) battery is 20 percent more expensive than a system that produces as much light but has three LED bulbs that are powered by a 20-Watt panel and a 22 Ah battery (2013). Their study is based on the cost of a high-quality LED solar home lighting system priced at Rs. 9,900 ($165) in the market, and when amortized over a period of five years at an annual interest rate of 12 percent, the monthly installments amount to Rs. 180 ($3). This cost is less than the combined subsidized and supplemental (unsubsidized) monthly cost of kerosene for the lowest ten deciles of household income in rural areas in India. Another study by the Lawrence Berkley National Laboratory (Phadke 2015) explains that declining costs of solar PV, the advent of LED lighting, and improvements in lithium-ion battery technologies have enabled dramatic performance gains and price declines in the pico-solar market (see Figure 1).

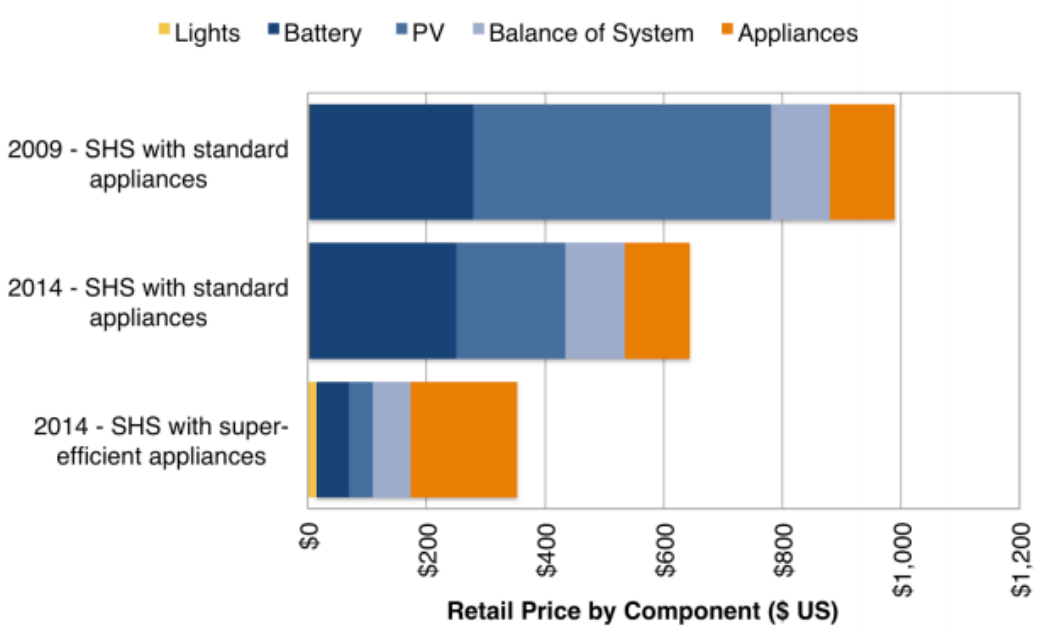
Figure 1



Note: Retail price of pico-solar off-grid products that provide 120 lumens (i.e. measure of brightness) of lighting service for four hours per day. Image source: Phadke 2015.

The same study analyzed the declining costs of solar home lighting systems with super-efficient appliances (a television, a radio, mobile charging, and a fan) to be sold as one package. The price declines between 2009 and 2014, for systems providing identical levels of service, thanks to technological innovation and reduced costs of manufacturing by over 60 percent (see Figure 2). These findings suggest that the combined impacts of high costs of kerosene, erratic electricity supply from the grid, and advancements in technological innovation supported by innovations in financing models overcome the low household income barrier to increase uptake of off-grid solar technologies in India.

Figure 2



Note: Retail purchase price for three SHSs that provide identical levels of service (four hours of 600 lumens of lighting, four hours of operating a 19-inch color TV, six hours of operating a small portable radio, and one charge per day of a basic mobile phone). Image source: Phadke 2015.

To leverage the declining costs of technology and the heightened ability and propensity of customers to pay for those technologies, firms are coming up with innovative finance models to successfully sell more of their products. However, these firms require capital for operations and to scale up their businesses. In 2011, the International Energy Agency (IEA) asserted that financing for "off-grid electrification of low energy expenditure households was the most challenging" type of finance to secure. According to the UN Foundation, accessing the "right kind and amount of capital at the right time remains one of the key bottlenecks to scaling-up decentralized energy solutions" (2015). Collective global funding requests for the sector amounted to over $1 billion in 2015.

In light of the shifting discourse, it is important to acknowledge that the challenge to the adoption and diffusion of off-grid solar technologies is not simply the cost-to-income ratio of the end user. This is contrary to what much of the literature argues (Balachandra 2011, IEA 2011, Wong 2012, Pode 2013). This paper will show that the more important factor for the diffusion of off-grid solar is the innovative financing introduced by entrepreneurs that make end users' access to energy more flexible and affordable. Furthermore, this research suggests that the firms which utilize these innovative models urgently require financing to help scale up their businesses.

3.2 Innovations in Energy Access Finance

The burst of entrepreneurial activity around off-grid solar technology distribution businesses in India has led to a variety of experiments in financing. Use of microfinance is perhaps the most tried example, but a number of other innovations are also relevant to the energy access market. These innovations, which are discussed below, include: solar technology rentals, use of remittances to pay for energy services, pay-as-you-go (PAYG) financing, and crowdfunding.

Some studies on microfinance reveal that access to modern energy is greatly enhanced when people have access to loans in order to pay for the technologies (Hilman 2007, Rao 2009). Microfinance loans differ from traditional lending in that they do not require access to formal banking institutions, as described above, and may also be subject to different conditions of repayment and interest rates. Microfinance can be used to improve livelihoods and eradicate poverty by providing people with small, manageable loans to support income-generating activities. Providing loans specifically for energy technologies that can be used for income-generating activities or increasing productivity is one of the primary ways in which microfinance is playing a role in helping expand energy access around the world. However, while conceivably a useful financial tool, in India, only 9 percent of the firms distributing off-grid solar technologies are leveraging microfinance for energy access (Singh 2016).

Another innovative financing tool is a rental model, which has been specifically applied to solar lantern uptake. Chaurey and Kandpal (2009) compare ownership versus fee-for-service/rental models of dissemination set up by The Energy and Resources Institute (TERI) based in New Delhi. However, their results conclude that a central charging station model (rental model) is not viable even with 100 percent capital subsidy support "if the households were to compare renting versus owning the solar lantern." In the rental model, the households would end up paying a daily rental that is more than the effective daily cost of owning the solar lantern. If the goal of an energy-poor household is to be energy independent, such technologies must lead to ownership when financially possible, not continued dependence.

Remittances may also have a role to play in financing energy access. According to the World Bank, India has remained one of the largest recipients of remittances for several years (Gupta 2015). While the use of remittances for energy has not yet been documented in India, efforts to channel remittances specifically towards energy technologies in Haiti (Akkari 2013) do suggest that successful instances using a large volume of capital to fuel the expansion of energy access technologies, such as solar, could be replicated in India.

Experiments in financing for energy access that leverage mobile technology and internet access appear more promising and transformative for the sector. Pay-As-You-Go (PAYG) is a concept that is familiar to most people in both the developed and developing world due to cell phone usage. A report by Arc Finance describes the "idea of paying for something in advance, only when needed, and in increments that match one's cash flow," as "easy, flexible, and appealing to the energy poor" (ArcFinance 2014). PAYG models highlight that the challenge of financing energy access technologies is not simply affordability, but also

flexibility of payment mechanisms. This flexibility mirrors how people pay for electricity through the grid: a monthly electricity bill that is flexible according to how much energy a household consumes, unencumbered by the total upfront costs of the energy generation and distribution infrastructure. The energy poor in India increasingly have access to mobile phone technology, which allows them to use PAYG for access to energy that is tailored to their needs. Micro-grids and solar home lighting systems, coupled with mobile phones in an interaction termed Machine-to-Machine (M2M) technology, afford the opportunity for people to use PAYG financing for off-grid energy access (Nique 2013). Nique estimates that the "energy addressable market" of people living without electricity access but having mobile phones in India is approximately 85 million people (2013).

In India, companies such as SIMPA Networks, OMC Power and Gram Power are pairing these methods of weekly tariff collection with their solar technologies to provide electricity services. In the case of SIMPA Networks, customers make a small down payment on the SHS provided by the company, and their weekly payments go towards eventual ownership of the product. They are essentially paying down the entire cost of the system over time. Should they choose not to continue service, the product remains the property of the company.

Barriers exist for the advancement of PAYG SHS technology in India. First, mature mobile money markets are required to support PAYG financing; these markets are not as developed in India, where regulations have, until recently, restricted mobile money transfers. In addition, quality metering technology and an appropriate business model (either partnering with a cellular service provider or developing one's own technology) are also important factors associated with PAYG financing (ArcFinance 2014). Nonetheless, this financing innovation promises to accelerate access to energy for millions more, and to do so without the need for subsidies for end users.

Another financing innovation for the energy access sector, "crowdfunding," describes "the practice of raising funds in small increments from large numbers of non-institutional sources" (ArcFinance 2014). Crowdfunding generally requires an online platform that can be promoted using social media campaigns, thereby leveraging the social networks of non-institutional sources to contribute towards the advertised early-stage companies or projects. A few major enterprises have emerged that host these platforms for raising funds such as Kiva, Indiegogo and Kickstarter. In India, there are only a few online crowdfunding platforms, including Rangde and Wishberry. Another organization, Milaap, combines microfinance with crowdfunding by facilitating crowdfunding of microloans for a variety of organizations. These platforms are now being used to finance off-grid solar technologies in India.

As India's online retail market booms, the opportunity to capitalize on online crowdfunding could be significant. However, barriers remain: regulations of the Security and Exchange Board of India (SEBI) do not allow returns on investment for any funds raised from the public, unless the company goes "through the complicated and costly procedure of listing on a stock exchange" (Lopicich 2015). Many early-stage companies that are currently operating in the energy access space are far from being listed publicly. Thus, investors are largely those who are interested in philanthropic giving, and those who contribute micro-loans using

Milaap's platform would have to be flexible about return timelines and understand that they will not receive interest on their payments. Or in the case of Wishberry, investors would only be given access to gifts provided by the hosts of the campaign as incentives. Regardless, the potential for raising funds for energy access through crowdfunding could be enormous. According to one estimate, by the end of 2015, approximately 2,000 energy access campaigns were funded through crowd platforms with an average campaign size of $1,725 (Cogan 2016). For India, which attracted $55 billion in remittance flows in 2010, the possibility to use some of those funds for energy access through crowdfunding platforms would make a substantial impact.

4 Methodology

This study employed various methods of inquiry to capture players both in the formal and informal markets. This research relies on fieldwork involving site visits to customers of several different off-grid solar technology firms in different states and villages. Methods include structured telephone interviews of operators of government-authorized solar retail shops known as "Akshay Urja"[12] shops, semi-structured in-person interviews with representatives of various off-grid solar technology firms operating both in the formal and informal market, semi-structured interviews with the customers in villages who are utilizing off-grid solar technologies, and semi-structured interviews with financial institutions. In addition, the study draws on the results from a structured online survey of 69 off-grid solar enterprises operating in India (Singh 2016).

4.1 Structured Telephone Interviews

With the help of research firm Outline India, between May and July 2014, I contacted 170 government-authorized retailers of off-grid solar technologies from across the country to ask about their solar businesses. Respondents were given no incentive to participate and were told that the purpose of the interview was to research how such technologies are distributed in the country. My research team and I conducted interviews in regionally appropriate languages with the help of translators. We then procured a complete list of registered retailers and their corresponding contact information from the Ministry of New & Renewable Energy website. We attempted to contact registered telephone numbers four times before the shop was deemed inactive. We asked how many of which types of off-grid solar products were sold on average per month. Respondents had several categories to choose from, including solar lanterns, solar home lighting systems, solar water heaters, and solar streetlights. We also asked respondents how many of these products per month were reported to require maintenance from their customers. Finally, respondents were given the opportunity to elaborate on factors that may be affecting the ability of their firms to succeed.

[12] The Indian national government established at least one Akshay Urja solar technology shop per district throughout the country. The purpose was to create nodal business models that could be replicated across the country. This program has been terminated as of June 2017.

4.2 Semi-structured Interviews

I interviewed a total of 74 customers of nine different off-grid solar technology firms during the course of this study. Most interviews were conducted in 2014, though this study also draws upon field visits I conducted with two firms in late 2007 and early 2008. Primarily, respondents were from the states of West Bengal, Bihar, Uttar Pradesh, Rajasthan, and Karnataka. The interviews were designed to assess: 1) the demographics of the customer base of off-grid solar technology firms; 2) how and if the purchase of the technology was financed; 3) servicing and maintenance issues; 4) fuel switching; 5) quality and satisfaction; and 6) livelihood improvement or augmentation.

Figure 3: A map of states visited for field surveys

In addition, I conducted in-person semi-structured interviews with representatives from 19 different off-grid solar technology firms. The purpose of these interviews was to understand in greater detail the business plans of the firms operating in this market, the challenges faced, and the opportunities leveraged as these firms have grown in size and customer base. Among the topics explored was the role of financing in the distribution of their products, the partnerships the firms had with financial institutions, if any, and the role of government in helping or hindering the expansion of their businesses.

Entrepreneurs operating in the informal market for off-grid solar products are seldom mentioned in academic literature, despite having a large presence throughout the country. These businesses manage to sell significant volumes of off-grid solar lighting products, which they purchase wholesale, and assemble in affordable customized packages for their clientele. Little has been written about their business models, or how much money they are able to generate through sales. These entrepreneurs are nonetheless a crucial part of the local solar energy ecosystem, and can be found throughout the country in areas where electricity access is lacking or unreliable. I interviewed 10 solar entrepreneurs operating in this informal space from the states of West Bengal, Bihar, and Uttar Pradesh. Discussions focused on the entrepreneurs' monthly sales for various products; customer product preference and methods of payment; maintenance issues; the educational background of the entrepreneur; and factors that may affect their business, such as the arrival of the central electric grid in previously un-electrified areas.

Six financial institutions of various sizes and types participating in the energy access market were also surveyed about the finance gap in meeting the energy access challenge in the country. These included the startups Milaap and Wishberry, which offer online micro-lending and crowdsourcing solutions, respectively, as well as representatives from the Self Employed Women's Association (SEWA), the Small Scale Infrastructure Development Fund (S3IDF), Micro-energy Credits, and a rural branch of the Union Bank of India.

4.3 Data Limitations

The main objective of this study is to challenge the traditional notion that the lack of adequate government-funded end-user financing is the major barrier to faster diffusion of off-grid solar technologies in India. I do this by exploring emerging financing models that make access to energy through those technologies affordable and reliable. Gathering sensitive information—regarding household income from people in rural India, or sales data from private entrepreneurs—is difficult. All such data, no matter the source, or by whatever means gathered, should always be questioned. People are hesitant to accurately report financial information, such as household incomes, because they may not want to be investigated by government authorities or lose their privilege to subsidized goods under government welfare programs. This study attempts to address this limitation by asking whether people paid for a product using cash or a bank loan, and how many installments they paid. These factors could be better proxies to analyze the financial aspects of the off-grid solar business in a particular geography. It is also possible that the firms and

entrepreneurs surveyed were not entirely truthful about the sales figures (although they had no incentive to inflate their figures.)

Finally, socio-economic context, culture, and business environment vary across a landscape as vast as India. Thus, it is important to gather as much information as possible from across the country to test any hypotheses regarding financing of energy access technologies in India at large. This study compensated for this potential data limitation by conducting customer surveys from diverse geographies including the states of Bihar, Rajasthan, West Bengal, and Karnataka. It must be noted that the sample size of the customer surveys is not sufficient to draw statistically significant conclusions. Nonetheless, the data provide valuable insights into the on-the-ground realities of financing off-grid solar technologies in India.

4.4 Method of Analysis

I used a mixed methods model to synthesize and analyze the different types of data from the surveys, interviews, and experiments. A combination of process tracing, content analysis, constant comparison, and analytic induction were utilized to identify the emerging patterns of the study.

5 Results and Discussion

Energy access financing cannot be explored through a single lens or with any one methodology. Using the various methods discussed above, many stakeholders such as financial institutions, off-grid solar entrepreneurs, and customers were engaged to gain a better understanding of the role financing plays in the diffusion of off-grid solar technologies in India. To answer this question, the following sections unpack the results. First, interviews with customers shed light on the types of financing tools which are currently used to purchase two different types of solar products in four different states. Second, insight into customers' ability and decision to pay is explored through interviews with informal solar sales agents and analysis of micro-grid tariffs from across northern India. Finally, the case for greater emphasis on financing for the firm versus the customer is made by examining a government-supported off-grid solar technology deployment program as opposed to the types of financing innovations used by private companies and individuals to facilitate sales.

5.1 Customer Financing Realities from the Field

This section explores end-user perspectives on financing by examining the results of semi-structured interviews from four different states in India (West Bengal, Bihar, Rajasthan, and Karnataka) of various kinds of technologies and enterprises.

5.1.1 Bihar

In July 2014, I conducted a randomized, semi-structured survey of customers of Green Light Planet (GLP), a solar lantern manufacturer and distributor, in several villages in the Vaishali District, Hajipur block of the state of Bihar. The villages visited included Chowsian, Parveja,

Gangajal Tola, and Badhuraiya. A total of 14 households were visited in the area. On average, each of the households surveyed had 4 different solar lantern products sold by the company. Ninety percent of all homes in Chowsian village and 50 percent of the homes in Parveja village possessed the company's products at the time the survey was conducted. Seventy-nine percent of the respondents had more than one product, with the highest number bought by one household being 12 products.

GLP's business plan in the region is based on the concept of direct marketing, the use of door-to-door salesmen who are incentivized to make sales using a system of monetary incentives. Customers are not provided any form of financing and must usually purchase the product through up-front cash payment. Though not encouraged by the parent corporation, at the discretion of the sales agent (who is locally known), customers can choose to set up a short structured timeline for completing payments. Customers are guaranteed after-sales support and maintenance during the included warranty period received with the product.

All the respondents were male between the ages of 17 and 60 years old. The average household size in the area is 13 people, which typically includes joint families. Every home had children who were enrolled in formal education. Nearly all households surveyed were involved with agriculture either as a major source of income or a supplemental one. Some of the other occupations represented include: poultry farming, dairy/animal husbandry, convenience store operation, kerosene retailer, railways employee, and a tutoring center.

All the homes visited, as well as those located near them, were made of formal construction material. People in the area were growing onions, which at the time of the visit were highly valued across India due to shortage and price inflation. It was noted that several people in these villages were now able to sell their excess kerosene that had been substituted with solar lanterns. All surveyed households had access to electricity through the central grid. The majority of homes reported having 12 hours of electricity access through the grid every day. Some noted that the grid had been more stable in the last six months.

On finance, respondents were asked whether they found the pricing of the company's products to be appropriately priced. Sixty-four percent of the respondents stated that they initially thought the price of the company's products (ranging from $10–$40) was too high. However, after acquiring the product and realizing the savings, they said that the pricing was appropriate. All of them paid using cash, and 50 percent of them paid in a single installment while 36 percent paid in two installments. The remainder paid in three to four installments. Those who paid in multiple installments had generally done so because they found the product to be expensive or questioned the quality of the product and the resulting savings they would accrue over time by switching from kerosene. Recalling Harish (2013) and Urpelainen and Yoon (2015), these results support the argument that small off-grid solar products, such as lanterns, have easily become cost-competitive for low-income rural households. Further analysis of this business model (Singh 2017) reveals that village-level entrepreneur networks may facilitate large volumes of sales quickly and easily without relying on formal financing mechanisms, to which so many Indians living in rural India lack access.

5.1.2 West Bengal

In July 2014, 27 households were visited in the villages of Nagendrapur, Harod, Bagnan, Bangalpur, Uttar Sundaraganj (G-plot), and Govindapur Bhojobalipur, predominantly in the districts of the 24 South Parganas and Howrah in the eastern state of West Bengal. All of them were customers of the Kolkata-based private company Onergy, a private company which distributes solar lanterns, solar home lighting systems, and establishes micro-grids for remote communities in the region. The solar lanterns distributed by Onergy are made by Green Light Planet and are usually sold without any customer financing options. Solar home lighting systems encountered during the field visits varied from 40 to 200 Watt systems with LED-based bulbs, charging ports for mobile phones, and in some cases televisions and fans. These SHS are sold to customers either without financing options, or with local bank financing that allows the customer to take advantage of government subsidies. Onergy's micro-grid customers who were visited had three lights and a mobile phone charging port. Onergy establishes micro-grids with the help of grants from foundations that assume the risk for communities or individuals who wish to own and operate their own micro-grids. Some individuals are able to take on a bank loan to set up a micro-grid for their communities, and set up their own payment structures for tariffs (they charge local customers who need electricity) in order to pay back the loan.

Respondents in all the villages of the 24 South Parganas district lacked access to central grid electricity; the six households visited in Howrah district, on the other hand, did have access to the central grid. This connectivity differential is probably due to Howrah district containing a major urbanized beltway in the state, whereas the 24 South Parganas are at the fringes of the state in a mangrove forest and swamp region known as the Sundarbans. Forty-eight percent of the respondents were female; the age of the respondents ranged from 17 years to 57 years old. Occupations of the respondents varied but largely consisted of subsistence agriculture and small-scale fishing. Most of the sites were individual homes, but a few of the products were used in small shops, an NGO, and a remote post office. The average household consisted of six people. Nearly all the homes visited in the 24 South Parganas were made of earthen construction material while those in Howrah district were made of modern construction material.

On affordability, 64 percent of the respondents who purchased solar home lighting systems thought the pricing was appropriate, while 30 percent thought it was too high. Nearly 90 percent of these respondents, whether they thought the system was appropriately priced or too expensive, would recommend purchasing solar home lighting systems to others. On financing, 30 percent of the respondents who purchased solar home lighting systems paid in cash for the whole system, while 70 percent used bank loans and were able to take advantage of government subsidies. These figures did not appear to be correlated with whether the respondents considered the systems appropriately priced or too expensive. The respondents who used bank loans were organized by a local NGO, and had their applications collectively submitted to the local rural bank in order to expedite the process. This suggests that institutions outside of the off-grid solar enterprise may be able to facilitate the use of a complicated government subsidy regime with greater efficiency and scale than the enterprise itself. Given the complex nature of accessing government-supported end-user subsidies for

off-grid solar technologies in the country, and the shifting realities of people's willingness to pay, the CEO of Onergy suggested that while government subsidies were important for his business initially, they may have served their purpose and may no longer be required for conducting sales. Instead, he argued that the technology was sufficiently socialized—among the people in the regions where he operates—to not require subsidies for customers as an incentive.

5.1.3 Karnataka

In April 2008, a randomized, semi-structured interview was conducted among 15 households in Sugatur village of Kolar district in the southern state of Karnataka. The respondents were decision-makers within their households, with one-third of respondents being women. All households owned solar home lighting systems distributed by SELCO, an established off-grid solar energy enterprise based in Bangalore, Karnataka. The solar home lighting systems they owned ranged from having four to eight bulbs, with some systems also including additional capacity for charging cell phones or other small appliances.

Sugatur is the *gram panchayat* headquarters for local area villages; thus, it is easily accessible by road. The median household income in Sugatur, as reported by SELCO, was Rs. 40,000 ($856) annually at the time of the visit. The primary occupation is agriculture and sericulture (silkworm farming); however, many people interviewed also operated small restaurants or provision stores as primary occupations. The average household size was eight members, but several of the homes visited during the field visit had small families of just four people, and several did not have children. One hundred percent of the homes visited were formally constructed, and it appeared that that the majority of the homes in the village were of similar quality. Finally, Sugatur village is considered 100 percent electrified, and all the homes visited had access to grid electricity.

When questioned on pricing, financing, and willingness to pay, all respondents said they would be willing to buy another system as needed, given the experienced benefits. Approximately 73 percent of the respondents said they would be willing to pay for a solar system using a loan. The remaining respondents did not wish to use a loan, and many had paid for the first system using cash. Some people reported that they were about to purchase their second system during the time of the field visit. Some respondents claimed to receive a small discount on a third system if they purchased two systems. The cost of a solar home lighting system from SELCO at the time the survey was conducted started at $125 and increased based on the needs of the customer. Most of SELCO's products are customized based on the needs and affordability of the customer. The price list changes, but the Manager of Innovations at SELCO stated the following on affordability of their systems: "Anybody who can afford to pay Rs.100-150 (approximately $1.60–2.50) per month for five years can afford a single light system which lasts more than 15 years with one battery replacement. Similarly, somebody who can pay Rs.250 ($4) per month for five years can afford a 4-light system lasting for a similar time period." Customers can access microcredit loans and take advantage of government subsidies from a variety of banks with which SELCO has formed partnerships. According to SELCO, the interest rates vary depending

on the source, but are between 10–13 percent. Customers make a down payment of between 10–25 percent and pay the remaining balance over a period of three to five years.

These findings reflect the fact that SELCO, an industry veteran in the off-grid solar lighting space in India, has worked hard to build the financial ecosystem needed to support sales of its products. SELCO has done this in a number of ways: 1) by experimenting with tailoring products according to the needs of customers to match products with potential customers' ability to pay, and 2) by managing the relationship between customers and banks so that the former can have access to financing. This effort has meant that SELCO has focused on the needs of people in the state of Karnataka alone, and not been able to (nor wanted to) scale beyond one state, as so many of the emerging off-grid solar enterprises in the country wish to do. It is important to note that the CEO of SELCO said that government subsidies have not had the desired effect of helping the ecosystem of off-grid solar technologies grow.

5.1.4 Rajasthan

The final case this study draws from is the most unusual. In February 2006, each of the 52 homes in Dabkan village of Alwar District in the northwestern Indian state of Rajasthan were given (free of charge), some of the first[13] LED-based solar home lighting systems in the country by the company Grameen Surya Bijlee. Yet no supply chains for replacement parts were established and no after-sales maintenance or warranties were provided to the community. Furthermore, at the time, there were no government standards or specifications for LED-based solar lighting technologies. The home lighting systems in Dabkan each consisted of one 10-watt solar PV panel, one 12-volt battery, and two 15 or 22-light LED bulbs. In November 2007, surveys were conducted in 18 households—or 35 percent of all households in Dabkan. The large majority of respondents were decision-makers within their households, and 89 percent fell within the labor-contributing age range of 18 to 49. Twenty-eight percent of respondents were women.

Dabkan is accessible by dirt road from the nearest rural nodal town, Tehla, three kilometers away. It is 55 kilometers southwest of the city of Alwar, and 105 kilometers northeast of the capital of Jaipur. Because Dabkan is located within a government-designated forest, grid electricity is prohibited from reaching the area. As reported by a local school teacher, median household income at the time the survey was conducted was $25 per month or $300 per year. This did not include the effective income generated by subsistence agriculture production, nor the collection of fuel wood and dung for home energy use. In Dabkan, income is primarily derived from milk sales and animal husbandry. Many young men also pursue seasonal work outside of the village, typically in nearby mines, where they earn $1.60 –2.50 per day. The average household has seven members, of whom an average of three are under the age of 12. On average, in each household, two members attend school. Roughly 60 percent of homes were formally constructed, while the remaining 40 percent were informally constructed using earthen compounds and thatch.

[13] Since the time this survey was conducted, LED lighting has become more commonplace in India. At the time the survey was conducted, LED bulbs had to be imported into the country.

Because the households were given the systems free of charge, customers were instead questioned about their willingness to pay for such systems. It is important to add that the lack of proper supply chains for replacement parts and after-sales maintenance meant that nearly all the SHSs in Dabkan required some level of servicing. To assess whether households would be willing to pay for such systems, given the benefits they had experienced,[14] various questions were asked of each household, depending on which was contextually appropriate. In each case, respondents were asked whether they would be willing to take out a bank loan of between $50–100, assuming one would be available, to make such a purchase. Questions included the following:

1. If you did not already have this system, would you wish to pay to have one?
2. To acquire a new light bulb or solar panel, would you be willing to pay for it?
3. If you could gain additional uses, would you be willing to pay for an upgrade (more bulbs)?

In 81 percent of households the answer was yes—they would be willing to pay for the system or improvements. In the remaining households, respondents reported an unwillingness to pay because of exceptionally low income. In several homes, respondents were asked to provide the maximum loan amount that they would be willing to take out to pay for the system or improvements. Typically, the answer to this question was $100.

The findings of this case, which surveyed perhaps the poorest income group in the country, suggest that even amongst the absolutely destitute, there is a willingness to pay for off-grid solar lighting products, especially when alternatives do not exist and people understand the value of the technology, as cited by Urpelainen and Yoon (2015). However, for such a low-income group, access to a financing mechanism that makes payments easy and affordable would be necessary. Perhaps models that have emerged since the time this survey was conducted—such as PAYG—would be appropriate for such an income group to eventually purchase off-grid solar technologies upfront (should they wish), or to make easy and affordable payments based on their needs.

5.2 Insights into Customers' Ability and Decisions to Pay

In the following sections, we explore the ability and decisions of customers to be able to pay for off-grid solar technologies. Much can be gleaned from the interviews of informal sales agents of off-grid solar technologies; sales agents are embedded in local communities and conduct business without involving formal financial institutions. Sales data collected from these agents suggests that many end users have the ability to pay for such technologies.

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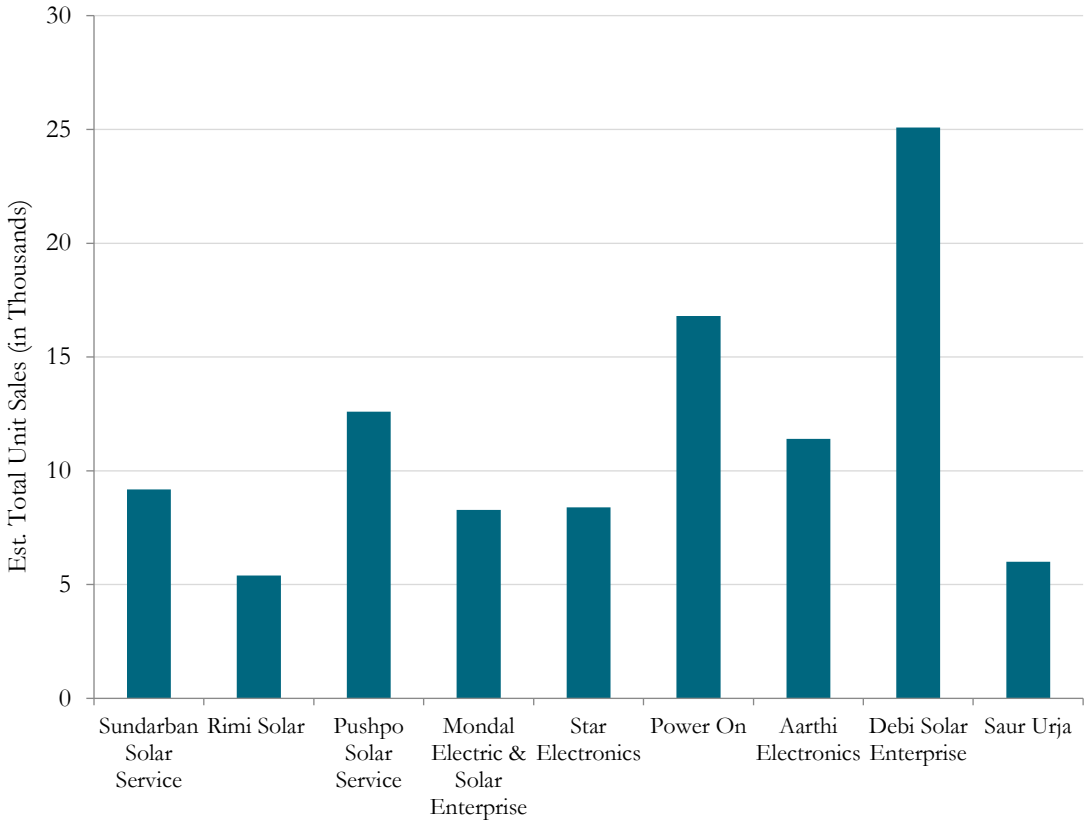
[14] As a result of having the solar home lighting systems, households cited that children's education outcomes improved and overall household productivity after sunset increased. In addition, households reported decreased indoor air pollution as a result of reduced burning of kerosene. Reductions in consumption of kerosene from fuel switching (kerosene to solar energy) were as high as 5 liters per month per household, bringing down total household consumption on average to just 2 liters per month.

Finally, a snapshot of micro-grid tariffs from across north India further adds to the discussion of affordability and decisions of end users to pay for a basic level of service.

5.2.1 Informal Solar Sales Agents

Semi-structured interviews of nine off-grid solar entrepreneurs (operating in the informal market but within the market ecosystems of enterprises in the formal market) were conducted. Eight of these were in the state of West Bengal, operating in the same market ecosystem as Onergy; one was in the state of Bihar, operating in the same market ecosystem as Green Light Planet. General questions were asked about their business, including their annual or monthly sales, financing, maintenance support provided, and their customers. Eighty-nine percent of the entrepreneurs had received technical training on solar or electrical engineering, and 56 percent of them could conduct assembly of products on site (specifically solar lanterns, or small DC appliances).

Figure 4: Estimated total lifetime unit sales of informal solar dealers in West Bengal and Bihar (based on current monthly units sold)



Note: This figure depicts the estimated total lifetime sales of SHS and solar lanterns per informal solar sales agent encountered in the field in West Bengal and Bihar. Data is based on estimated monthly sales data during July 2015.

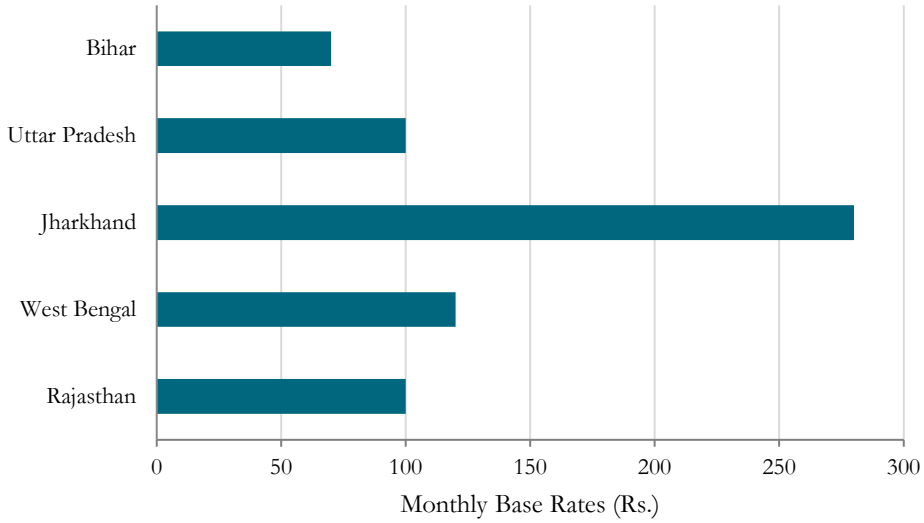
All the agents reported that their customers paid in full with cash, and all of them provided after-sales support and upheld the manufacturer's warranty provisions. This is a notable

demonstration of end users' ability to pay, as the sales of some of these agents can be as high as 200 solar home lighting units sold per month at a retail price of $500 per unit. Figure 4 depicts the estimated total lifetime (averaging 6 years of operation) unit sales (including solar home lighting systems and solar lanterns) of these informal sales agents. Sales data used for these lifetime calculations is from around the time the interviews were conducted, suggesting that monthly or annual sales figures in the past before the arrival of the electric grid in many of these areas was likely much higher. These findings further support the reality that financing solar energy access in India is complex. Furthermore, it suggests that the research community must move away from a paradigm that sees government-supported financing for the end user as the only solution to accelerate the uptake of these technologies, and towards a paradigm that seeks to support business innovations that allow even the poorest people to make easy and affordable payments for technologies. One way to support this potentially large group of informal sales agents is to make solar engineering courses available at the 6,000 Industrial Training Institutes which are owned and operated by the government. This would form a network of solar engineers who could create localized business models to sell off-grid solar technologies according to customers' needs, and ensure the existence of after-sales support and maintenance.

5.2.2 Lessons from Micro-Grid Tariffs across North India

Micro-grids have been changing the face of energy delivery in rural India. They are often seen as a more effective and efficient way to provide a small community access to electricity, and to do so more affordably for the end user. Several enterprises have been established across the country that capitalize on this technology. Some of the important factors to consider when evaluating micro-grid projects are the establishment of tariffs, security of the equipment, and management of the system either by an enterprise, an entrepreneur, or a community. The long-term financial viability of any micro-grid project is determined by the amount of money generated to sustain operations through the collection of tariffs from the end users. This study interviewed a variety of off-grid solar enterprises that are operating micro-grids in India. A sample of base tariffs (providing roughly the same quantity and quality of service) from across enterprises operating in five north Indian states is depicted in Figure 5. The monthly rates range from a low of USD $0.83 to a high of $4.50.

Figure 5: Sampling of monthly base tariffs for micro-grid projects across north India.



These results indicate that, even with monthly tariffs for electricity provision through micro-grids, people are willing to pay substantial amounts for the same level of service. Rather than the issue being about their ability to pay, perhaps it has more to do with how that service is packaged and the local circumstances. For example, the micro-grid in question in Bihar has an extremely low tariff that was agreed to by the community, despite a willingness to pay—determined by a pre-project survey of the community—that was two to three times the established amount. As you can see in Figure 5, the state of Jharkhand has a significantly higher monthly base tariff rate compared to other states with micro-grids. Rates are higher in Jharkhand because residents near the micro-grid are illegally squatting on property owned by the Indian Railways Corporation; these citizens do not expect to ever gain access to the central grid. Thus the decision to pay of those end users is significantly higher than those in other regions. An employee of Gram Power, a micro-grid company based in Jaipur, Rajasthan recounted that a community that once had access to electricity through the centralized grid but lost service due to lack of payments several years ago was willing to pay up to $8.30 per month per household to regain electricity service.

Representatives of Pune-based Gram Oorja and Auroville-based Sunlit Futures argue that the initial capital needed to establish a micro-grid is too high for some communities in parts of rural India. However, after the system is established, tariffs can be arranged such that the community is willing and able to pay for the system, its replacement parts, and a staff person to operate and manage the system. These factors, especially the tariffs, can be customized according to the community's needs.

Finally, representatives of the micro-grid company, Mera Gao Power, noted that based on their experience with rural communities in the state of Uttar Pradesh, there is a significant difference between respondents' "decision to pay" and "ability to pay." Mera Gao Power representatives claim that they have regularly encountered customers who refused to pay for monthly services when they knowingly could afford it (as evidenced by consumer goods they

chose to purchase).[15] Anecdotal evidence reveals that pricing of base-level service for micro-grids across the country is dependent on local contexts. These insights suggest that firms are designing new business models to ensure that end users in a variety of geographies and income levels can access electricity services through solar micro-grids and firms are still able to recuperate their costs.

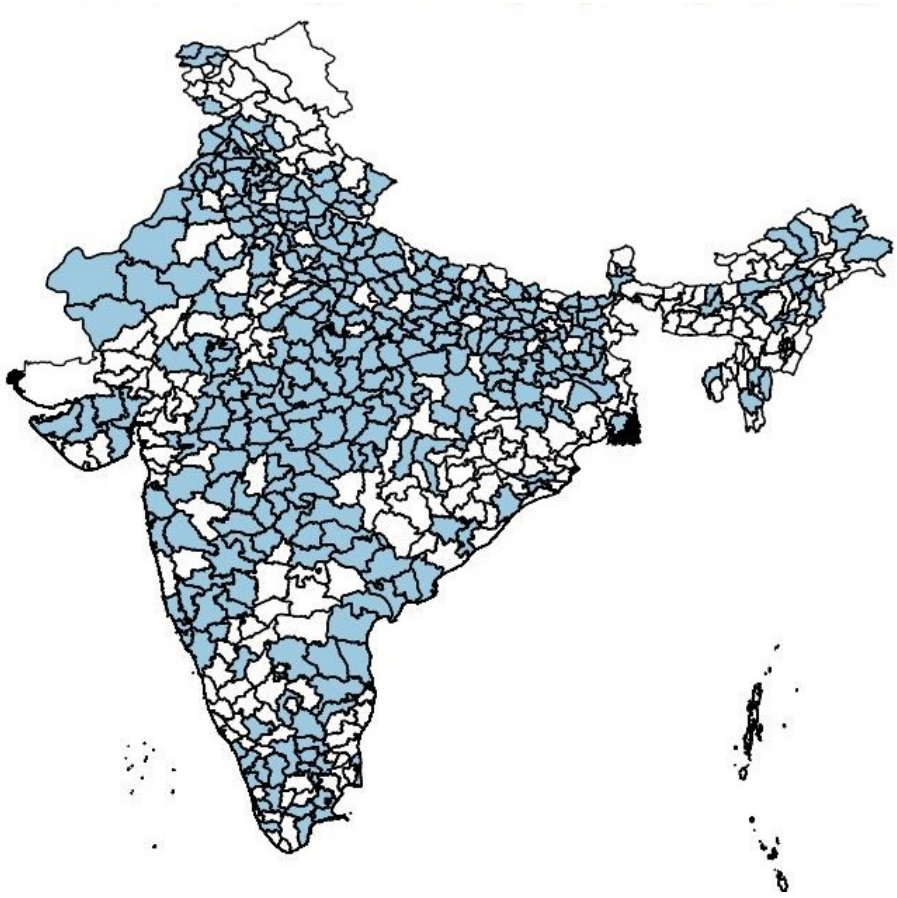
5.3 Financing for Whom by Whom: Innovative Companies and Entrepreneurs

Following extensive field work and analysis of off-grid solar enterprises in India, I have uncovered a significant pattern for the debate on off-grid financing. Broadly speaking, the complexities of financing for off-grid solar technologies suggest that government-supported end-user financing is not a silver bullet to increase access, as previous literature claimed. While the poorest segments of the population may still be unable to directly purchase solar technologies, innovative business models have made it possible for many to be able to pay for services provided by off-grid systems. However, firms employing such models require financing to scale up their businesses, specifically on improvements of "delivery, installation, and ongoing maintenance" (UN 2016). Aside from reductions in costs associated with innovations in the technologies, what helps to bring these technologies within reach of the end user are companies and entrepreneurs with innovative business models that make financing for the end-user easy and reliable. This prompts the question: should financing focus on traditional government financing for the end-user, or on financial and policy support for the agent with the innovative model to make access to the technology more affordable for the end-user, or both?

[15] One specific example is a customer who chose to pay approximately Rs. 80 ($1.30) for a bag of chips but did not want to pay Rs. 25 ($0.42) for the week of service he received through the micro-grid.

5.3.1 The Akshay Urja Case

Figure 6: Districts with open Akshay Urja shops



Note: Akshay Urjay shops (in blue) by district at the height of the program in 2012.

The Ministry for New & Renewable Energy launched the Akshay Urja program in 1995. The program was designed to establish government-owned retail outlets for the sale, repair, and promotion of off-grid solar technologies. Recognizing the burden of operating these shops, the government began providing incentives in 2002 for private entrepreneurs to establish these shops. Paltry monetary incentives[16] for meeting monthly sales targets—as well as compensation for utility costs of running the shops—served as incentives for private entrepreneurs to become government-authorized retailers of solar energy technologies. Government financed end-user subsidies for the technologies and an unreliable electricity supply helped enable the success of these entrepreneurs. At the height of the program, approximately 400 Akshay Urja Shops existed across the country. Many years later,

[16] Entrepreneurs are provided with $83/month for manpower and utilities as well as a flat $83/month for a monthly minimum turnover of $833/month in the first year of the shop's operation and the same incentive for minimum turnover of $1666/month starting the second year of the shop's operation. In addition a soft loan at an interest rate of 7 percent to a maximum of 85 percent of the cost of the establishment of the shop along with a one-time publicity grant of $833 is available to the entrepreneur.

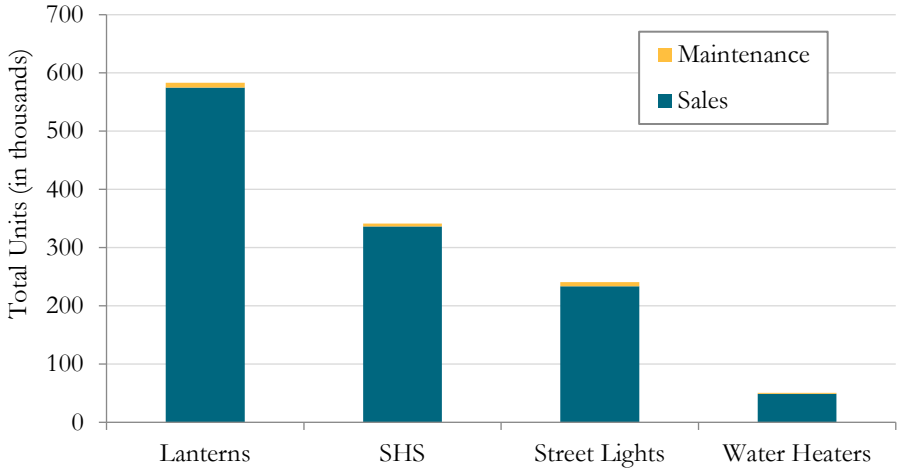
government subsidies for the end user have not always been disbursed in time, and electricity supply has expanded across the country. Without greater incentives to drive innovation to compete in the changing market, many entrepreneurs simply closed their shops and at the time this study was conducted only 174 shops were publicly listed on the Ministry's website.

Figure 7: Akhsay Urja shops across India

Note: Green markers indicate shops which were open and responded to the survey, orange markers represent shops that gave partial responses to survey questions, and red markers indicate shops that were closed.

Results from the phone survey show that out of 174 publicly listed shops, approximately 53 were still in business (see Figure 7). Most of these shops are clustered in a few states, where electricity access was still unreliable at the time of this survey. A breakdown of their sales and maintenance data reveals that while the shop owners managed to make significant sales, they received few requests for servicing and maintenance (see Figure 8). It is important to note, however, that shops do not offer in-home servicing and are located in district headquarter towns that are far from many of their rural customers. Furthermore, if shops were truly competitive they would provide quality after-sales servicing and maintenance; these services are common among private companies which are not supported by subsidies.

Figure 8: Total Units Requiring Maintenance vs. Overall Sales by Product



Note: A comparison of sales versus maintenance by product among Akshay Urja shops still in operation at the time of the survey.

Many of the shop owners lamented that the extension of the electric grid to their regions began suppressing demand for their products, and that continued government subsidies for end-user financing were required to maintain comparable sales rates. While this may be true for a certain segment of the population, particularly middle-income residents of peri-urban areas, this is not relevant to poorer customers in areas farther from district headquarters. Furthermore, it contradicts the fact that the majority of firms in this sector are selling off-grid solar products in areas where the grid is already present (Singh 2016).

The Akshay Urja shops program created a retail network of standardized quality products for sale across the country. The program also spread awareness of solar energy capabilities for communities with unreliable or no energy access. Unfortunately, the Akshay Urja program failed to provide incentives to individual franchises to make off-grid solar products more accessible and affordable on their own, especially as competition from the grid increases. Carefully managed, entrepreneurs in the network could share information on best practices for enhancing sales. As a result of these shortcomings, however, entrepreneurs were not able to reduce their dependence on government-supported subsides, nor to take advantage of plummeting prices of solar PVs to continue sales. In June 2017 India's Ministry of New & Renewable Energy announced it was canceling the Akshay Urja program.[17]

5.3.2 Companies

As discussed earlier, companies which utilize PAYG technologies can bring electricity access to millions who are energy poor, and who may not want to pay the upfront costs of solar technology (or might want to make payments towards eventual asset ownership, as is the

[17] Ministry of New & Renewable Energy Notice No. 325/2/2017-AUS, June 20, 2017.

model of SHS provided by SIMPA Networks). However, companies need capital and revenue to be able to scale up their businesses. In 2015, PAYG companies specifically raised $160 million in financing. Investment crowdfunding will disrupt traditional venture capital financing by spreading risks and benefits among larger groups of people, and circumventing risk-averse, state-run banks. New investment structures, such as crowdfunding, will continue redefining the investment landscape and ultimately lead to more extensive energy access. A supporting example is the case of a successful crowdfunding campaign conducted on the platform provided by the company Wishberry. Over 45 days, with contributions from 89 private individuals, an entrepreneur managed to raise twice the amount she needed to purchase two 3-kW micro-hydro unit turbines to help electrify 50 remote households in the northeastern state of Arunachal Pradesh.

Finally, for customers who require financial assistance, and need or want to continue to take advantage of directly purchasing off-grid solar technologies such as SHS, the rise of models companies such as Micro-Energy Credits should be supported. Micro-Energy Credits plays the role of intermediary between banks and potential customers and facilitates access to solar loans. At the time of the interview, in just four years of operating in India, Micro-Energy Credits had facilitated loans for 124,700 SHS and 10,000 lanterns thanks to partnerships with local banks. The company relied on a strategy of bundling the transactions it facilitated for carbon credits as a source of revenue. Micro-Energy Credits facilitates awareness of the technologies and accelerates solar loan transactions, thereby reducing the burden on solar technology firms such as SELCO, which otherwise often need to match customers with banks and serve as an intermediary between the two, at significant cost to the firm.

5.3.3 Entrepreneurs

The role of individual entrepreneurs, who are locally embedded in the communities which either have unreliable access or no electricity, is imperative to diffusion and maintenance of off-grid solar systems. Entrepreneurs can provide innovative financing options for the end-user in order to increase sales. Numerous off-grid solar enterprises in the country are leveraging these entrepreneurs in order to be able to conduct business. The ability of a firm to create a franchise network that is owned and operated by an independent agent also relies on financing, which is the organizational model of Orb Energy. Orb Energy's extensive franchisee network across southern India facilitates a large range of sales of products from solar water heaters to SHS. Individuals who wish to go into the solar business request a loan from a bank in order to open an Orb shop, and become exclusive dealers of Orb's products. A system of commissions on sales and incentives for meeting sales targets keeps the entrepreneur interested in continuing to sell Orb's solar products.

In the realm of micro-grids, entrepreneurs are slightly wealthier individuals (likely pre-existing entrepreneurs in rural areas) who wish to acquire an affordable loan to set up a solar micro-grid. That individual can then set up a tariff structure and provide access to electricity to last-mile households, where it might be difficult for firms based in urban areas to reach.

Such a case was witnessed in the Sundarbans region of West Bengal. Similarly, informal sales agents can utilize the power of bulk purchasing to assemble SHS packages that might be more affordable to the local communities than the products offered by firms operating in the formal market. Take, for example, the entrepreneur encountered in Bangarmau, Uttar Pradesh, who was advertising deep discounts on sales of 20-watt or 40-watt SHS with two LED bulbs and a clean cook stove for $80 or $117, respectively (see Figure 9).

Figure 9. Advertisement of SHS packages for sale with discounts in Bangarmau, Uttar Pradesh

In conclusion, locally embedded entrepreneurs who can overcome the perceived barrier of end-user financing through the use of innovative business models to diffuse off-grid solar technologies should be the focus of government and multilateral development assistance. Furthermore, policies which facilitate standardization of quality technologies and access to training on repair and maintenance will strengthen these important members of the off-grid solar energy ecosystem.

6 Conclusions and Policy Implications

This study suggests that government-supported end-user financing, as currently structured, may not be the most effective means in accelerating the diffusion of off-grid solar technologies in the country. This form of end-user financing is limited by the fact that a large segment of the population which requires off-grid solar technologies does not have access to the formal banking sector. Furthermore, firms that wish to pass the savings of subsidized solar products on to their customers face bureaucratic hurdles, resulting in loss of time and revenue.

By examining the experiences of both the firms and the end-users, this study suggests that the focus of financing for the diffusion of off-grid solar technologies should shift from the end-user to the firm and entrepreneur. For firms, financing is required to pilot projects, accumulate inventory, and expand the customer base to reach a point of financial self-sufficiency. For the customer, while financial constraints are at times a reality, often the factors affecting the decision to pay are more important than the ability to pay. Contrary to widespread assumptions, many people have the ability to pay for these technologies. Innovative financial models of off-grid firms should thus address customers' decision to pay. The decision to pay is influenced by experience with a product, association with a sales agent

or company, and/or exposure to technology through others in the community. Innovative financing tools can both make products more affordable (addressing the end users' ability to pay) and more accessible (addressing their decision to pay).

The government's policies to expand solar energy to 100 GW in the country's energy mix by 2022 and provide universal energy access by 2019 are admirable goals, but must realize the limits of the existing subsidy regime which will likely need to be used to meet these targets. The existing governmental policy directives (and corresponding allocation of resources towards the diffusion of off-grid solar technologies) fail to drive the required financial innovation in the business of making solar energy technologies more affordable and accessible. Government efforts are not matched by the capacities of the banks to provide loans for customers. This mismatch is further complicated by the lack of awareness of the technology among the customers and the bank branch managers. Failure to increase familiarity with technology for all stakeholders will result in missing the opportunities presented by other government policies, such as: 1) the financial inclusion initiative to provide access to formal banking for millions of first-time users; and 2) the direct benefit transfer program to channel subsidies for energy, allowing the customer to choose how (and on what technology) to spend the money.

Instead of only allocating funds to *subsidize* financing for off-grid solar technologies, the Indian government should create an additional fund to support business innovation for the technologies that can be used by existing companies, start-ups, or individual entrepreneurs. The recently launched $8 million PACESetter Fund, established jointly by the US and the Government of India, may serve as a good pilot to explore the impact of such a fund, because it finances firms with the most innovative business models to scale access to energy through off-grid technologies like solar. The success of such initiatives can be tracked over time by measuring the growth of such firms in the number of customers they serve, or by measuring the decrease in number of people nationally who are dependent on government subsidies for fuels such as kerosene, which is the main competitor for off-grid solar technologies.

Finally, the current government has indicated the desire to capitalize on Indian diaspora living abroad, and the need to increase foreign investments into the country to help meet development targets. Thus, improving the business environment to support emergent forms of financing could leverage foreign actors to help scale up and realize the true potential of emergent innovations, such as crowdfunding and PAYG technologies. Specifically, the government should remove bottlenecks for conducting transactions through mobile payments, allow foreign contributions for energy companies, and allow small investors to receive interest for loans specifically for crowdfunding efforts for energy access. In addition, targeted relaxation of the Foreign Contribution Regulation Act (FCRA), a regulation that inhibits access to foreign capital by organizations less than three years in operation, could free critical early-stage capital to support non-profit institutions who play a supporting role such as training and education for the diffusion of solar technologies.

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