Consilience

FIELD NOTE

In India's Sea of Darkness:
An Unsustainable Island of Decentralized Energy Production

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Abstract

Approximately 500 million people in India's countryside are still without access to electricity. The government has launched an ambitious project to electrify the entire nation by 2012. Unfortunately, the term "village electrification" defines electricity distribution for only 10% of households. An equally ambitious plan by the Ministry of New and Renewable Energy states a goal to electrify about 25,000 of the remotest villages in India. In these villages, it is inefficient to extend the grid with decentralized, renewable energy systems. The economic development of a large portion of India's population depends on the success of decentralized energy distribution. This development will help provide the means to eradicate poverty. Ensuring the success of these systems requires a closer look at the rural energy ladder. One must go beyond just lighting in order to establish a paradigm for integrated sustainable energy independence for India's rural villages. Whether India decides to power its villages through grid-fed coal power or through decentralized renewable energy systems, this decision has major implications for global climate change. This study assesses the benefits and drawbacks of one such distributive power system: solar home lighting.

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One and half years ago, Grameen Surya Bijlee (a Mumbai based non-profit), distributed LED (Light Emitting Diode)-based solar home lighting systems to 52 homes in the remote village of Dabkan, in the tribal area of the Alwar District of northeastern Rajasthan. The home lighting systems in Dabkan consist of one 10-watt solar photovoltaic panel, one 12-volt battery, and two 21 or 33-light LED bulbs which provide four to six hours of light. "There was nothing here ten years ago except jungle, and we were only connected to the outside world when the road was built" explains Babu Lal, the only shop owner in the village. Because of the road, one of the men running Grameen Surya Bijlee stumbled across the remote village with a truck full of supplies that they were unable to install in another village. As independent analysts, Dave Madan and I traveled to this village to assess the impacts of the solar home lighting systems on the families: the problems, benefits and the barriers to successful continuation of such a lighting scheme in this part of Rajasthan or any other part of India. This assessment was for the benefit of not only Surya Bijlee but also the Renewable Energy Corporation of Rajasthan, which has to date installed approximately 90,000 solar home lighting systems throughout the state.

Rural India's Dilemma:

Approximately 500 million people in India's rural areas have yet to see the light of "India Rising" as the media has literally described the recent economic growth. 700 million people in rural India are still dependent on biomass fuel for their energy needs and as many has 500 million people still have no access to electricity. The government's ambitious plan to electrify the entire nation by 2012 is in large part based on providing these homes (particularly some 25,000 of the remotest villages) with decentralized renewable energy systems. Decentralized renewable energy systems consist of local energy generation and dissemination systems unlike a large national or regional grid. It is important to add that when the government says "rural electrification," it means providing electricity to a mere 10% of the households in a village. Thus, decentralized renewable energy systems (as opposed to just the extension of the national grid) offer the best hope for a more *complete* electrification of India's villages. There are many types of such systems depending on local availability of resources (micro-hydel, solar, biogas, bio-mass gasification, etc.). However, for this part of the country, solar energy is the best option because of year round availability of high solar radiation. Also, LED – the next revolution in energy efficient lighting – is helping people in the dark leapfrog into a new era of home lighting. This new LED revolution has helped the poor by reducing their dependency on dirty kerosene, which consumed much of their meager income and was injurious to their health.

System Drawbacks:

Unfortunately, after five to six months of use, approximately 60% of the bulbs that were distributed have had some level of damage. Most importantly, the bulb holders have broken and individual LEDs have fused within the bulb (some reporting 10-15 fused LEDs in a bulb). This could perhaps be due to the poor quality of manufacturing of the bulbs. The various parts of the system were sourced from China and distributed as Surya Bijlee's products. The occasional solar panel is also damaged due to incidents involving monkeys, peacocks, and even rats eating the wires. These are all important factors to consider when designing future home lighting systems for rural areas. All of the recipients were adequately trained in the maintenance of the system. The villagers essentially only needed to keep one foot by one foot thin-film solar panel clear of dust, because the dust can affect the efficiency of the system, particularly in a desert environment. One of the other questions is of brightness of the

system. "When we provide light, our [Compact Fluorescent] bulbs give off 600 lumens whereas [Surya Bijlee] provides only 100 lumens of light" exclaims Sudir Mohan, head of Rural Electrification at India's Ministry of New[2] & Renewable Energy Sources, the only government agency dedicated entirely to such a cause anywhere in the world. At first sight, it appears that this really isn't enough light. When asked about the amount light the bulbs emitted, approximately 70% of the respondents claimed it was adequate lighting but most agreed it could be brighter. At night, the effect was clear. In a sea of darkness, the small LED bulbs made a large difference. We could see the light created by the bulbs from far off and the light seemed adequate to extend work hours, keep the bugs out of the food while eating, and even keep the scorpions and snakes at bay. It perhaps was not the best lighting for reading, but the LED bulbs still made a difference by alleviating some of the major concerns of the villagers.

Benefits:

"We are very happy with the system and we would like more installations," said one of the villagers. Indeed, the lighting systems benefit the villagers immensely in terms of general lighting needs. The majority of the respondents of the survey said they used the LED-based lighting system to extend their work hours at night or early in the morning. The system was used specifically for their children's studying needs as well as necessary kitchen lighting for cooking. The occasional person even used the system to charge mobile phones (there are only two in the entire village) and flashlights. The villagers dream of a day when they would be able to power fans, televisions, and even water pumps.

There are approximately 52 homes in this village with joint families having seven to eight children in each home. Formal surveys were conducted in 18 households, or 35% of all households in Dabkan, with the assistance of the village schoolteacher, Deendayal Sharma. The large majority of respondents were decision-makers within their households, and 89% fell within the labor-contributing age range of 18 to 49. 28% of respondents were women. In addition, an informal survey was conducted of several homes during the night to assess the effectiveness of the home lighting systems. One hundred percent of the respondents claimed that they had seen their children's study habits improve after the installation of the solar home lighting system. "When I first started teaching here five years ago, most of the children couldn't even write their names properly, and they would fail tests even when only 50-60 percent marks were required for passing," stated the village school teacher. "It took me one and half years to just get them to memorize the prayer we do in the morning before starting school." Thanks to the extended hours of study provided by the lighting system, there has been a 70% improvement in retention of knowledge and on average students are studying one to three hours longer than they did before. "Our kids can study until late even after we have all gone to bed," said Choti Devi. This is particularly important in rural areas where children often have chores until sundown which allows them to be free to study only in the dark.

"Would you prefer electricity from the grid or from such solar installations?" I asked every interviewee. "This LED-based system, of course, because there are no bills!" bluntly stated Pal Brindiyal. The dependability of the grid was also often questioned, and rightly so in a nation which struggles to provide reliable electricity for even its urban centers. Then there is also an issue of safety: "If I get in a fight with my wife, she may go outside and put her

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[2] *The standard incandescent bulb in the US produces 10-17 lumens/watt of light while a standard CFL produces 50-70 lumens/watt. Source: US Department of Energy*

hands on the live wires," joked Lalu Ram, who received the lighting system just in time for the birth of his first child. The truth is that in rural areas many of the wires are uncoated so they do present a threat to people, particularly curious children. But the national grid has no prospect of ever reaching this village, because it falls within the National Forest lands. By Indian law, infrastructural development is kept at a minimum within designated National Forest Land areas. This is in large part to minimize deforestation and human-wildlife conflict which would happen with human habitations being situated close by. Because this particular village is near a famous Project Tiger reserve, Siriska (now devoid of tigers), it falls within the forest land area which provides a buffer to this wildlife sanctuary. In an effort to continue to move people away from forest areas and make it easier for the government to provide them services, people living in designated forest areas have no choice but to move out (if they want services) and advance the process of urbanization in India.

The LED bulbs reduced the village's dependency on kerosene. According to the villagers, the light emitted by the LED bulbs was brighter than their kerosene lanterns. Of the people we interviewed (approximately 40% of the households with the installations), there was a 50% or greater reduction in consumption of kerosene on average. A few households, including Madav Ram's, saw their consumption of kerosene drop from 11 liters a month to absolutely none. This has major implications for climate change as well. According to Surya Bijlee, of the 87 million homes still burning kerosene in rural areas in India and consuming 100-150 liters per annum at the expense of 2.6 kg of CO_2 emitted per liter, there is immense potential to reduce the total 22 million tons of pollution being generated currently. Though this may seem meager compared to CO_2 emissions coming out of developed countries, it is vital in helping rural India leapfrog past a carbon based economy.

Also, all of the interviewed villagers claimed that the home solar lighting system saved them money, because they no longer needed to purchase kerosene. This is important for households in this village where incomes are typically 10-12,000 rupees a year before expenses, and the cost of kerosene can be as high as Rs. 1800 anually, proving to be a significant dent (up to 20 percent) in the household budget. Since almost all the homes are dependent on some level of animal husbandry, Madav Singh's response was particularly interesting: "the light provided by the system has helped me save money because it has made the calving process easier for my animals which earlier suffered greater mortality rates during delivery."

At the end of the visit, the lingering question of financial feasibility remained. A single home lighting system consisting of one solar plate and two bulbs costs Rs. 3,250 (approximately $80) and these poor villagers had received them for free. With no nearby outlet for repairs and purchasing of more LED bulbs, essentially an unsustainable island of decentralized energy production had been created. There were no clear pathways for progress. Surya Bijlee hoped that the pilot project would spur the villagers to want to purchase the next system out of their own pocket money (which many do not have) or take a bank loan to finance the purchase. Seeing the benefits, approximately 80% of respondents said that they were willing to take a bank loan to finance the purchase of more home lighting systems. But who would provide these villagers with loans? It is known that interest rates for loans to villagers are very high and even the villagers themselves joked that they would take the loan "but paying it all back was an afterthought."

The Future:

Perhaps a micro-finance scheme is required for the dissemination of such technology throughout rural

India. The recent formalization of a policy by the Indian government on micro-finance might help expedite such schemes. Already certain private banks are beginning to take an interest in funding small scale projects. "You see, people don't want to pay for things," stated Mr. Mathur, a Project Officer of Alwar District for Renewable Energy Corporation of Rajasthan. "In the past, we provided free solar home lighting systems and people refused to pay the monthly Rs. 100-200 for the new battery their system would require within two years." Currently, a 35 kilovolt solar home lighting system, provided by Rajasthan Electronics and Instruments Ltd. which powers three CFL bulbs and has a bigger solar panel, costs approximately Rs. 10,000 base price and Rs. 6,500 after the government subsidy. One of the villagers in Dabkan had such a system and it was significantly brighter and more durable than the supposedly long-lasting LED bulbs.

When asked about consumption of wood before and after the solar home lighting system, all respondents reported no change. According to the Ministry of New and Renewable Energy, in a nation where 84% of the rural household's energy is needed for cooking, this may be an interesting point to consider. Some villagers in Dabkan are also dependent on diesel powered pumps to bring water to their fields. "It would be nice if we could use the light from the sun to power other things," stated the shopkeeper Babu Lal, "for instance, the village mill."

Clearly in terms of the overall energy ladder of the rural home, home lighting is filling only part of the gap. The important question is whether this offers only a "half-leap" in terms of providing for the energy needs of those in India's countryside. "Solar is the only viable option that works across the country," according to Mohan. "But solar is not true electrification as it can only provide lighting." I noticed a lot of animal dung readily available in the village because nearly everyone is dependent on animal husbandry for part of their income. Perhaps it is time to consider the utility of biogas as a possible energy source used by the villagers. Solar cannot be the only answer. Instead, integrated renewable energy systems, a method of development which employs various renewable energy technologies in combination to provide for the various energy needs of a community, might not only pave the way for sustainable development, but rather represent the *entire* leap into sustainable energy independence for remote areas in India and other parts of the world. In the case of Dabkan village, biogas, which could be harnessed through effective use of already available household biogas digester technology in India, could go a long way in making their lives more sustainable.