Enable access to legal electricity and affordable green energy solutions

CONTEXT

Despite India's progress in recent years to extend electricity to urban slum houses, 13 lakh (1.3 million) households do not have access to electricity for their lighting needs (Census of India, 2011). The unreliable power supply also remains a major obstacle. For instance, one-fifth of the urban households in the country have power outages at least once a day. Cities and urban areas in states like Jharkhand continue to experience intermittent supplies, facing daily power outages of five hours (Agrawal et al., 2020). Additionally, there are several barriers to accessing legal electricity connections. Due to the temporary nature of their slum houses, residents are often unable to provide the required documentation such as proof of permanent residence for electricity connection. Lengthy complex processes and tedious paperwork make it difficult to avail benefits of legal electricity, forcing the poor to resort to the more expensive illegal connections. Challenges of the physical environment also have a rippling effect on the energy needs and the availability of energy infrastructure for the poor. Data suggest that in the absence of adequate natural lighting in tightly packed communities, urban slum residents are forced to rely on artificial lighting sources for more than eighteen hours a day (Debnath et al., 2017). Lack of ventilation in slum dwelling units induces heat stress, further compelling them to use energy for cooling their homes. This implies that they end up using more electricity, thus increasing expenditure on energy. Temporary roads and unplanned dwelling units also restrict the construction of basic services essential to providing electricity.

Awareness about the health and financial benefits of legal and cleaner energy access as well as knowledge about energy-efficient sustainable products is limited in informal settlements. In some cases even today, the poor continue to rely on traditional and polluting fuels such as firewood, kerosene, chips, and dung cake for meeting their energy requirements. When homes double as workplaces, the challenges of energy poverty extend to poor women's work. Women spend the majority of their time indoors, engaged in their livelihood activities, and attending to chores. Working below the minimum required level of lighting becomes an occupational hazard, leading to issues with their eyesight. Due to the informal nature of their livelihoods, they are unable to afford the required infrastructure, such as meters, wires, appropriate stoves, and safe construction materials. As opposed to working in a factory where the employer takes care of the cost of production, when these women carry out their trade from home, home-based workers are required to bear the production cost themselves, including the cost of utilities. Basic infrastructure deficiencies, such as electricity shortages, hinder productivity, while utility costs eat into their available income.

Many poor women's livelihoods also depend on the usage of electrical appliances. For instance, home-based workers in the embroidery business employ electrical tailoring machines while those running a grocery store from home may use refrigerators that consume substantial amounts of electricity. At the end of every month, they are burdened with very high electricity bills which adversely affects their household's financial situation. On average, a home-based livelihood consumes around 300-400 units of electricity and spends between INR 1200-INR 1500 (USD 16-USD 20) per month, i.e. 30-40% of the women's monthly income! (Brahmbhatt et al. 2019). Moreover, they are also forced to rely on small-scale inefficient technologies that undermine their earning capacities.

MHT'S APPROACH

Access to efficient and affordable energy is critical to the poor who spend a major part of their small household incomes on energy for lighting, cooling, heating, and powering home-based livelihoods. Mahila Housing SEWA Trust (MHT) believes that there is a need for innovative approaches to provide affordable energy to the poor, particularly slum communities, which can go a long way in reducing their energy expenditure, maintain quality of life and, more importantly, enhance their production capacity.

For more than twenty years now, the organization has been working in the energy sector enabling slum electrification programs, supporting renewable energy products, and building capacities of women to conduct energy audits and adopt more efficient technologies.

MHT has also extensively worked to promote the use of efficient and renewable energy appliances and technologies specific for livelihood purposes. For instance, for some women involved in sewing, embroidery work, and selling groceries, the organization has promoted a complete shift to solar power. From monitoring energy consumption and promoting solar-powered equipment that focuses on enhancing incomes and productivity of home-based workers to advocating for pro-poor renewable energy policies, MHT has significantly contributed to taking the poor up the energy ladder by increasing their access to legal connections and cleaner energy sources.

VIMLABEN
TAILOR

Daulatpur,
Bhopal

"We used to access electricity by connecting a wire to the nearby supply pole. The connection would often get cut because of traffic and other disturbances. We used to go for two to three days at a stretch without electricity. In 2011, MHT supported us to get legal electricity connections. Now I have a metered connection and the supply is reliable and continuous. My kids are able to study for longer hours. I can run my electric sewing machine even at night."

Enabling legal electricity connections

Energy companies are often unwilling to invest and engage in informal settlements and resist slum electrification efforts. They often perceive it as a poor return on investment, especially in settlements where illegal connections and theft is common. The lack of legal status and land ownership is also a crucial barrier in extending electricity in informal settlements. MHT started working on enabling access to energy in informal settlements in 2001, as a partner organization in Ahmmedabad's slum electrification program (Box 1). The program demonstrated a successful model of slum electrification that brought together local governments, utility companies, local NGOs and communities in program design and implementation. MHT plays a crucial role in mobilizing and educating communities, encouraging them to acquire and pay for legal electricity connections. Affording the basic infrastructure for electrification such as meters, wires, inverters, stoves, and safe connection materials is often difficult for poor households. MHT also supports households to pay for upfront costs by extending low-interest loans (Mahila Housing SEWA Trust, 2014, 13).

On the other end, MHT works with the energy companies to introduce process improvements like reducing paperwork, negotiating tenure requirements and instituting appropriate pricing and billing policy reforms for the slum residents. In Ahmedabad, slum electrification is now institutionalized and become so simplified, that a slum resident in the city, can easily avail electricity connection without any external facilitator. Based on the successful model of Ahmedabad, MHT replicated a similar approach in other cities like Bhopal. As a result of the efforts, more than 1.81 lakh (0.18 million) households across different cities are now getting access to safe and legal electricity connections.

For home based workers, access to reliable energy has resulted in longer work hours, more comfortable environments and access to productive electrical appliances, thus positively impacting their health and productivity.

Box 1

Instituting processes for slum electrification at scale

Ahmedabad

In 1998, the Ahmedabad Municipal Corporation (AMC) initiated the Slum Networking Program (SNP) that extended basic facilities like toilets, drinking water, sewage and paved roads in slum areas. MHT was one of the NGOs that spearheaded this work and mobilized communities to participate and contribute towards the cost of infrastructure. The project helped improve living conditions of the slum dwellers and inculcated in them a sense of trust towards government and authorities. After the success of the SNP, the slum communities demanded electricity connections, which led to the initiation of the slum electrification project. MHT collaborated with AMC and Ahmedabad Electricity Company (AEC) (Now Torrent Power) to start providing legal electricity connections in SNP slums in 2001. Building up on its experience of slum up-gradation, MHT devised a pro-poor model of electricity provision that also ensured that the utility company was able to recover service costs. As per the requirements of the poor, the bi-monthly billing cycle was changed to a monthly period for ease of payments. Moreover, AEC also agreed on the poor paying one-time installation charges in installments.

One of the key achievements of the slum electrification project was that it was further scaled and institutionalized at the city level. After the success of electrification in SNP slums, AEC recognized slum residents as paying customers wiling to pay for quality services. AEC started undertaking slum electrification in non-SNP slums, thereby making electricity accessible to more households. MHT supported in creating a slum electrification cell at AEC that ensured a single-window system for applications. The number of documents required for a connection was reduced, more importantly tenure requirements were negotiated to facilitate energy connection without requiring proof of legal ownership. AEC introduced an indemnity bond to ascertain that occupants could not claim tenure-ship on the basis of the bills and the connection.

Conducting energy audits and encouraging use of efficient energy products

For people residing in slum settlements, the low energy performance of their houses and the use of inefficient energy appliances often leads to a higher energy consumption and higher spending.

MHT trains grassroots women to become energy auditors to assess energy consumption of slum households, educate them on nuances of energy usage, and encourage them to shift to more energy-efficient products. The organization has devised a simple energy audit tool with a focus on reducing energy consumptions. The auditors survey common practices of electricity usage, mapping the house layout and household activities to suggest minor changes in light points, splitting light points, using lower wattage, etc. based on the household requirement. Households are also introduced to more efficient products like LED bulbs, fans of proven efficiency, better cook stoves etc. In cities like Ranchi, where electricity is highly unreliable, MHT links low-income households to alternate energy systems like the "Solar home lighting and cooling system" customized to their needs. MHT also encourages the trained energy auditors to become micro-entrepreneurs to supply and service green energy appliances and technology. This ensures a reliable supply chain and after-sales services for green energy products in low income communities.

Pilots in solar technology interventions for home-based livelihoods

The cost and frequency of the electricity supplied are important drivers for home-based workers. For instance, garment workers spend the majority of their expenditure on electricity to run their sewing machines. Irregular supply leads to a vicious cycle, with an inability to deliver goods on time and subsequent delay in payment (Mahadevia et al. 2014). Detail-intensive occupations like embroidery and *mala* (garland) making require artificial lighting even during the daytime. They often resort to inefficient appliances, like kerosene lamps, during irregular electricity supply that further shoot up their electricity bills. Additionally, ad-hoc construction of houses is not sensitive to extreme heat stress in slum-like residences. These intertwined challenges create an environment that is not resilient to extreme weather. It is neither conducive for income-generating livelihood activities nor suited for household activities.

Therefore, in 2018, MHT partnered with Selco Foundation to pilot solar technology interventions aimed at making home-based livelihoods more sustainable and cost-efficient. The pilots are aimed at demonstrating effective use of renewable energy to increase awareness and adoption, build trust, get feedback, and make improvements. MHT, with its AWAS SEWA GrihRin, has successfully executed ten pilot projects and subsequently installed solar-run energy systems for a hundred households.

	Occupation	Intervention
Sheeelaben Surat	Lace cutting and embroidery	Solar powered soldering iron
Geetaben Ahmedabad	Grocery shop owner	Solar powered refrigerator
Surekhaben Ahmedabad	Sewing and tailoring	Solar powered sewing machine
Dakshaben Ahmedabad	Printing and copying shop	Grid connected solar rooftop
Dheerajben Bhuvaldi	Cattle rearing	Solar powered milking machine
Meenaben Ahmedabad	Tailoring	Hybrid solar rooftop system
Laxmiben Chavda	Tailoring	Hybrid solar rooftop system

SHEELABEN EMBROIDERY

Bhaktinagar, Surat

"MHT conducted an energy audit in my house. We found that almost half of the total energy is consumed by the soldering iron that I use for lace cutting for my home-based livelihood. They installed a solar panel and taught me how to use it for the soldering iron, while also showcasing practices to maintain the system for maximum efficiency. I spend less time worrying about the electricity charges now and save around INR 600 (USD 8) on my bills every month."

Box 2

Pilots to promote solar technology in tailoring and embroidery enterprises

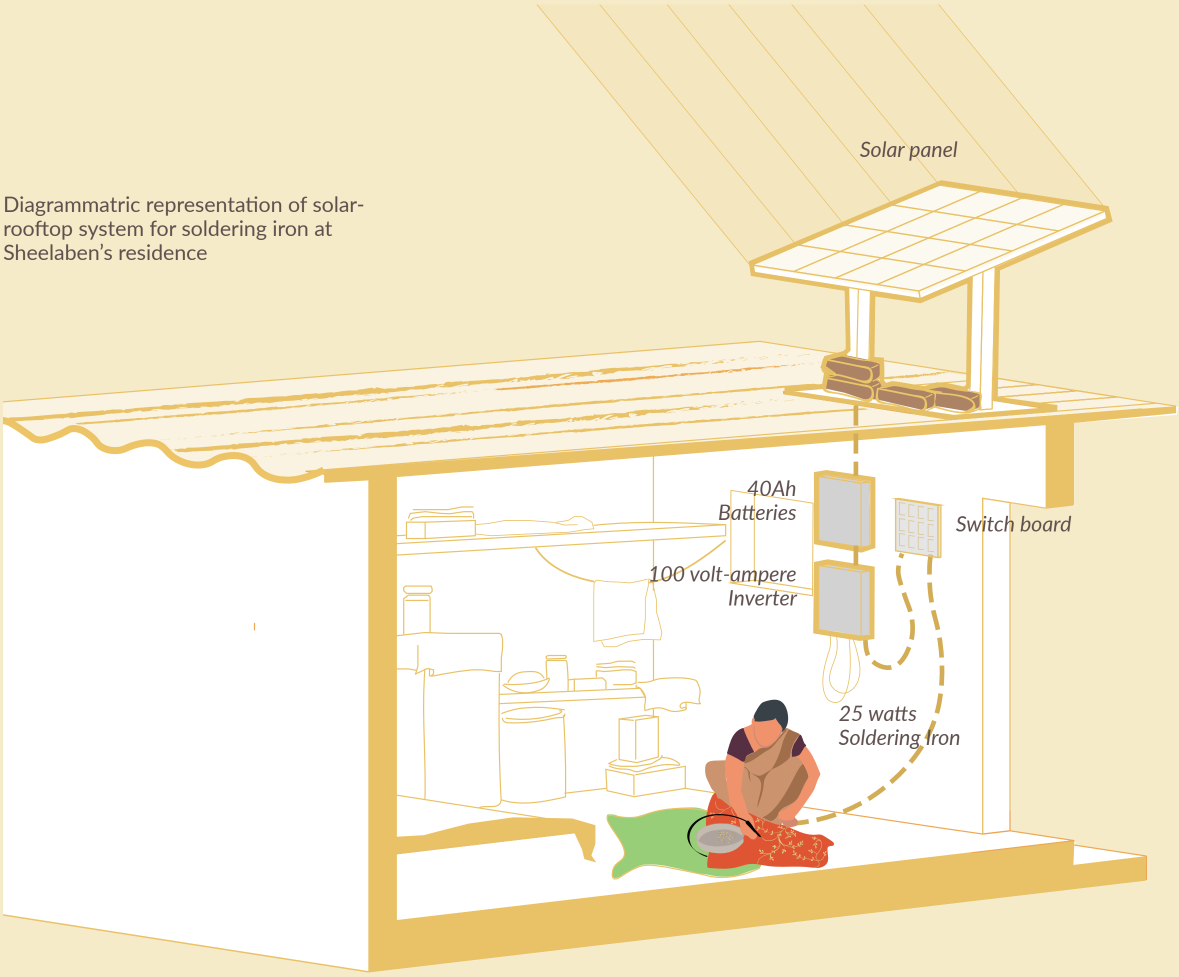
Bamroli, Surat

Sheelaben, from Bamroli in Surat, works as a home-based worker in lace cutting work using a soldering machine. The technical team from MHT conducted an initial audit to gather data on electricity consumption and the respective appliances used. On assessment, MHT found that the soldering iron consumes 25 watts of energy, owing to up to 46% of the total electricity consumption. Sheelaben's family was paying a monthly bill of INR 1000 to 1200 (USD 13 to USD 16).

MHT's intervention as a pilot project started by working out three scenarios as per Sheelaben's work hours and needs. With a focus on promoting efficient livelihoods, MHT introduced an off-grid rooftop solar system during her working hours from 9 am to 5 pm. After two months of the installation, a comparison of the electricity bill showed a reduction in cost by INR 400 (USD 5). The solar roof panel was connected to a wall-mounted solar battery and supported with an inverter to convert the generated direct current (DC) to alternating current (AC) for running the soldering iron. This also gives the family an option to connect two light bulbs, of 9 watts each, during days of no lace cutting work. This system increased Sheelaben's work efficiency, allowing her to work without worrying about electricity charges and power cuts. Sheelaben observed a 30% saving in her monthly electricity bill (Mahila Housing SEWA Trust, 2020, 26).

The position of the solar panel fixture was finalized with due consideration to the adequate shadow-free area from the adjacent buildings. The initial challenge during installation was subject to the existing asbestos tin roof, which required a sturdy support structure to hold the solar panels in place.

Diagrammatic representation of solar-rooftop system for soldering iron at Sheelaben's residence



Selco foundation operates with the motivation to implement socially, financially, and environmentally inclusive solutions to improve access to sustainable energy. The foundation provided technical training to the MHT team to build the organization's internal capacity to assess the needs of various livelihoods and the feasibility of deploying appropriate solutions to reduce the cost of electricity consumed. On the other hand, with each application of the pilot projects, Selco's technical team recognized the important role organizations like MHT play in mobilizing and educating communities on technical subjects and fostering a trust-based relationship between them and the solution providers.

The pilot projects were important in identifying bottlenecks in the implementation of energy-efficient systems and understanding the usage of the solar powered systems by low income households. One key learning for MHT was that too much customization based on exact needs of a particular household did not prove very helpful. The solar based systems that were installed were designed as per the specific requirements of a particular livelihood activity (and the required wattage). However, observing a substantial reduction in electricity costs, many families started utilizing the system for home lighting and cooling. They started connecting their fans and tube lights, thus overloading the system. This blurred boundary between household and livelihood work and indicated a need to scale the use of energy-efficient technology for a holistic approach. MHT realized the need to educate the families on regular maintenance of installed devices like solar panels and harness their complete potential and also support the adoption of grid-connected solar rooftop systems in energy-surplus states like Gujarat.

Enabling access to Government of India's grid-connected solar rooftop program

In 2015, the Government of India set up a huge renewable target capacity of 175 GW. Out of this total, 100 GW was earmarked for solar capacity of which 40 GW was estimated to be achieved through decentralized and the rooftop scale solar projects. As of March 2019, the rooftop solar program contributed to 14% of the cumulative solar installation in India. The interest in the adoption of solar rooftops in India can be attributed to high electricity tariffs for commercial and industrial consumers, favorable net metering policies, corporate social responsibility programs, and increased consumer awareness (Garg, 2019).

However, even with an apparent demand, the penetration of solar rooftop systems into lower-income households remains low. In Gujarat, the state government is leveraging its widespread electrification and encouraging the adoption of solar rooftop systems through a subsidy on the installation cost of the solar panel system. (40% subsidy on 1kW to 3kW capacity system and 20% subsidy on 3kW to 10kW capacity system).

MHT is supporting low-income households in the state to install solar rooftops and get benefits from these schemes. Other than educating households about the specifics and benefits of the scheme and supporting them with making applications, MHT plays a vital role in advocating with relevant authorities highlighting key concerns of low-income communities with the aim to

JAYABEN
TAILOR

Rajivnagar-3,
Ahmedabad

"MHT is helping us install a grid connected solar rooftop system for our newly constructed house. All our appliances including five tailoring machines and even a water pump will be able to run on it. However, there have been a few procedural challenges along the way. We do not have the pan card required to get the solar connection. So we have to submit alternate documentation. Also, we are required to upgrade from 1 KW consumption to a 3 KW system which might take further approvals. We are hoping that in four to five months we are able to get the system installed."

make these subsidy schemes accessible for them. For instance, it was observed that the average electricity consumption in most slum households in Ahmedabad is less than 0.4kW (Brahmbhatt et al. 2019). Therefore, low-income households would benefit from the subsidy scheme if the system is installed at a community level, and not limited to individual houses. When the solar subsidy scheme was introduced in 2019 in Gujarat, it was accessible for residential customers only at an individual level. Currently, MHT is working with the Gujarat Energy Development Agency (GEDA) for inclusive solutions, that can be introduced at the community level rather than limited to individual installations. MHT is also advocating with the government to design subsidy schemes that can cater to smaller needs.

Apart from supporting the penetration of solar rooftop systems in informal settlements, MHT also worked with the local government in Ahmedabad to successfully implement grid connected solar rooftop systems for public housing projects in the city. The energy generated from the solar systems is being used for lighting and operating common amenities such as public spaces and escalators thus reducing electricity bills for residents and promoting sustainable energy conservation practices.

LEARNING AND DIRECTION OF FURTHER ADVOCACY

1) It is common for State Governments in India to make populist promises like flat tariffs and heavy subsidies on electricity consumption typically before elections. The sustained implementation of fossil energy subsidies is a significant barrier to moving to clean energy and it also works against the long-term benefit of the poor. Revenue losses to the government because of these subsidy schemes translates to poor infrastructure and disruptions in service delivery. Residents have to face frequent power cuts and daily outages for longer durations. Unreliable electricity also means that the households have to bear the additional cost of running and maintaining generators. Low income households respond to poor service quality by ceasing to pay their bills and and bypassing their metered connections further amplifying the vicious cycle of poor and unreliable services.

There has been little discussion on bringing structural reforms with long-term benefits for the poor, such as de-linking service delivery from land ownership, making regular service affordable and making the process of accessing public services simpler.

MHT's experience from slum electrification in Ahmedabad has proven that slum residents, if supported through pro-poor service delivery mechanisms and suitable billing policies, have the willingness to get legal connections and pay for quality service, even when the tariffs in the city are much higher when compared to other cities. It is crucial that government and private electricity companies realize the importance of reaching out to the urban poor and recognize them as customers who are willing to pay for a good quality electricity supply.

2) The Government of India's solar rooftop program warrants process improvements to make the scheme more accessible to the poor. In electricity surplus states like Gujarat, grid-connected solar rooftop programs targeted towards residential consumers have the potential to scale up. But the overall adoption of residential consumer solar rooftop itself has been fairly limited despite the 30% capital subsidy offered by the government. Various factors have contributed to this slow growth. Bureaucratic hassles and procedural challenges make it difficult for households to get grid-connected solar rooftop systems. Delays in approval of net metering applications and untimely disbursement of subsidies hinder the adoption of the scheme.

Dependence on intermediaries for service delivery and last-mile connectivity is very high. Limited support from loss-making government-appointed distributors (DISCOMS) that fear revenue leakage, prevents penetration of the initiative. Navigation on online government portals is complex and the window for availing subsidies is limited, slots for which often appear unannounced. Policy uncertainty also complicates the process. MHT has also witnessed low adoption of solar energy solutions in states with extremely low residential electricity tariffs owing to highly subsidized legal electricity services.

Additionally, for the low-income households, low consumer awareness about the perks of renewable energy and knowledge about the scheme, as well as limited availability of finance for upfront payments, further reduces their chance of applying for the scheme. Much of the low income population is effectively excluded from the solar transition.

3) Density of development and poorly built physical structures pose a fundamental challenge to the adoption and expansion of solar-based systems at the individual household level in slums and informal settlements..

The densely packed houses reduce the shadow-free area required to exploit the sun's rays to implement the system. Also, houses with temporary asbestos sheet roofs, a common roofing material in informal settlements, require additional investment in time, material support, and effort to install a solar-based system. Space constraints pose a challenge to place the ancillary equipment like inverters, batteries, and meters required for a solar-energy system. Since the economic productivity of home-based workers is closely associated with their immediate habitat conditions, the poor physical quality affects their ability to incur the high upfront costs to shift to a renewable energy system.

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These briefs have been created for WIEGO and MHT by City Collab under the Urban Policies Program.

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