Case Study
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Creating Jobs and Income: How Solar Mini-Grids Are Making a Difference in Rural India

Executive Summary

Solar mini-grids can create jobs, help reduce energy poverty, and improve the electricity supply quality. Mini-grids increase energy reliability, delivering 24/7 energy supply for both income production and household needs. distributed renewable energy solutions such as mini-grids can serve as a complementary solution to national electrification in rural India.[1]

Distributed renewable energy providers in India, particularly mini-grid providers such as Mlinda, Smart Power India, and Husk Power, have adopted innovative business models that focus on driving local electricity demand by building local communities' capabilities. With their implementation of a more inclusive business model, these distributed renewable energy providers have overcome industry barriers to provide reliable electricity. In doing so, they have also created local jobs and fostered greater local economic activity.

As part of a series on renewable energy jobs, this case study highlights Mlinda's business operations model, which is described as the "energy and development services-based mini-grid model." Through research by the Natural Resources Defense Council (NRDC), the Council on Energy, Environment and Water (CEEW), and the Skills Council for Green Jobs (SCGJ), this case study shows how Mlinda's model improves the quality and reliability of electricity supply, provides jobs, and additional income opportunities in rural India.

Mlinda's community mini-grid deployment efforts have created an estimated 986 jobs from 2016 to 2020, on average, with the number of jobs created for each mini-grid ranging from 15 to 28. These jobs are created through direct employment or by creating entrepreneurial jobs from productive use electricity loads such as mills and electrified businesses.[2]

Solar mini-grids offer a tremendous opportunity for job creation, especially if paired with skill development, connection to markets, and affordable and longer tenure financing.

Solar mini-grids providers such as Mlinda and Smart Power India are expanding across India
Source: Smart Power India, 2016

Five Key Findings

1. Mlinda has connected nearly 7,000 households to their community solar mini-grid network, providing electricity to 35,000 to 40,000 people.[3] The company combines energy services with capacity-building initiatives, such as entrepreneurial training, technical workshops, and electricity awareness programs, helping the community stimulate demand for electricity as part of Mlinda's success.
2. Mlinda's community mini-grid deployment efforts created an estimated average of 986 jobs based on NRDC-CEEW-SCGJ analysis. These jobs include 180 direct full-time jobs, 131 full-time equivalent (FTE) jobs from contractual work, and 675 productive-use jobs through additional entrepreneurial activities.[4]
3. Households are willing to pay a higher tariff for electricity if paired with reliability, sufficiency, and services to improve livelihoods. Policy support and incentives have the potential to bring down distributed renewable energy costs, which in turn can make access to reliable electricity and development services more affordable for households.
4. An estimated 619,000 to 1,134,000 direct and productive use jobs could be created by adding 1,000 MW of new mini-grid capacity if Mlinda's "energy services and development-based" business model is replicated (see Appendix A for detailed definition of jobs and see Appendix B for job growth calculation methodology).[5]
5. "Energy and development services-based" business models for distributed renewable energy can create jobs, enhance incomes, and support local economic growth while supplementing the national governments' electrification efforts.

Section 1: Energy Access Challenges and the Role of Mini-Grids

Solar mini-grid power provides electricity for grain milling
Source: Mlinda, 2019

Access to affordable energy is vital to promote local economic growth and improve livelihoods. In 2017, the Indian government initiated the *Saubhagya Yojana* to prioritize universal access to electricity to all the willing households.[6] Through this program and other policies before it, an estimated 700 million people in India received electricity access between 2000 and 2018.[7] Despite the tremendous progress in electrification, energy poverty and the reliability and quality of energy supply remain critical issues.

For rural enterprises, grid-electricity use is often constrained. According to a rural enterprise survey across four states, nearly 40 percent of rural enterprises used non-grid sources for electricity, and several enterprises with high electricity demand used diesel generators for their operations.[8] While India's national grid has reached most villages, reliability is a critical concern.[9] Power outages in remote communities can be frequent, and villages can go days without electricity.[10] Distributed renewable energy providers are responding to these reliability needs and are electrifying both unconnected villages and grid-connected villages with dependable electricity.[11]

Studies show that addressing rural energy poverty can help increase GDP and improve living standards.[12] Reliable electricity is critical for rural communities' ability to capitalize on energy access benefits. However, electricity services need to be paired with capacity development initiatives such as technical and entrepreneurial skills training and access credit to finance appliances.

Distributed solutions, such as mini-grids, can help reduce energy poverty, boost electricity demand, create jobs, and offer a complementary solution to national electrification efforts.[13] Community mini-grid deployment efforts have demonstrated that mini-grids can bring significant socio-economic development around areas where they operate, predominantly rural.[14] Mini-grids can also create some local direct, indirect, and induced jobs and many more productive use jobs by creating entrepreneurial opportunities from productive use loads (see Appendix A for detailed definition of direct and productive use jobs). They can also enhance the rural electricity supply quality and efficiency, delivering reliable and clean electricity to power local businesses and stimulate rural economies.

Yet, initial mini-grid deployment efforts have faced several challenges.[15] The cost of deploying a mini-grid system is high—it includes high tariffs for rural customers, which raises affordability concerns. One of the primary reasons mini-grid providers have higher tariffs than the average national grid tariff is because distributed renewable energy providers receive no operational subsidies. In contrast, the electricity distribution companies of India (DISCOM) receive substantial subsidies. Additionally, the political feasibility of aligning development initiatives with national grid expansion efforts has led to some uncertainty regarding the scalability of mini-grids.[16] Lastly, distributed renewable energy providers that focus solely on energy services often find it challenging to maintain their customer base or energy demand.[17]

Electricity supply is vital but often insufficient to expand local economies, household incomes, and electricity demand.[18] Leading distributed renewable energy providers in India have adopted a more inclusive business model that focuses on services that extend beyond electricity supply. These providers have focused on building community capabilities by providing complementary services, such as extending credit to finance appliance purchases, running technical training and entrepreneurial skills programs, and creating market linkages for farmers and new entrepreneurs. Such initiatives have helped spur community development and have enabled these distributed renewable energy providers to secure reliable power demand and become self-sustaining. For this case-study, such a business model is called an “energy and development services” model.

One of Mlinda’s 45 modular solar mini-grids in Jharkhand, India
Source: Mlinda, 2019

Mini-Grid Basics

- **Solar Mini-Grid Definition**: A solar mini-grid is an integrated system that includes generation, energy storage devices, power conversion equipment, and distribution infrastructure; it provides both the generation and distribution of energy.[19]
- **Grid vs. Non-Grid Connection:** A solar mini-grid has clearly defined boundaries and can
- be independent or connected to the national grid.[20]
- **Capacity:** 10 kW to 100 kW
- **Productive Use Loads:** The use of electricity for economic development, using electricity to power small businesses, mechanization, and electrified agricultural equipment are examples of productive use loads.[21]

This case study outlines how mini-grids can provide reliable power, improve livelihoods, and create jobs. This analysis focuses on one mini-grid provider, Mlinda, and highlights a few other select distributed renewable energy providers' experiences. The following sections will detail how specific providers have built successful "energy and development services" based models focused on driving local electricity demand and sustaining productive use electricity loads. These distributed renewable energy providers have extended their services beyond power supply and, in doing so, have overcome industry barriers to provide reliable electricity, create jobs, and support local development.

Insights on distributed renewable energy policies in India, market actors, and industry hurdles were obtained through an extensive review of literature and government policies. Information regarding employment and mini-grid development strategies were obtained through semi-structured interviews with Mlinda between 2018 and 2020. These interviews informed our analysis on operational strategies, organizational structure, and employed workforce. Information gathered in these interviews, complemented by an extensive literature review and data from secondary data sources, was extrapolated to understand how mini-grid deployment could lead to sustained job growth (more details highlighted in Appendix B).

Section 2: Mlinda's Approach

Mlinda is a distributed renewable energy provider in Jharkhand serving residential and commercial energy needs with reliable power.[22] The company aims to use electricity as a development tool and seeks to end energy poverty through its work, i.e., deploying community mini-grids across rural India.[23] Mlinda has developed a four-step methodology for deploying and ensuring reliable energy service.

The first step is community engagement. Mlinda ensures that its services can meet each community's needs by first conducting a detailed survey to assess demand and ability to pay.[24] Mlinda's installation and pre-assessment model is rooted in building close ties with villagers; they ensure this by obtaining a household commitment of 75% or more upfront.[25]

The second step in their process is to conduct electricity load analysis and mini-grid design. This analysis helps Mlinda size their community mini-grid to provide the needed capacity to power residential and productive use loads.[26]

Third, their operations and maintenance personnel are locally-based, allowing Mlinda to build trust with the community members they serve.

Finally, Mlinda has a development team dedicated to working with communities to support micro-enterprises. The in-country team develops tailored strategies, such as connection to markets, regionally specific skills training, and productive use appliance financing to power local economies.[27]

Local workers installing the framing for photovoltaic (PV) solar panels
Source: Mlinda, 2019

Mlinda Business Overview

- **Mini-Grids**: Mlinda has installed 45 solar PV-hybrid mini-grids in Jharkhand, India; the average capacity of each community mini-grids is typically 23kW to 30kW.[28]
- **Storage**: Solar PV-hybrid mini-grids primarily utilize lead-acid batteries for storage. Diesel generators are used for back-up power in limited instances, such as inclement weather or battery failure.[29]
- **Productive Use Loads**: Mlinda focuses on powering loads that create new income-generating activities; Mlinda supplies power to millers, oil expellers, large irrigation pumps, and small irrigation pumps.[30]
- **Growth**: Mlinda has deployed and operates mini-grids in 45 villages and aims to expand to 125 communities by 2023.[31]
- **Internal Rate of Return (IRR) per project**: The IRR of each mini-grid project is around 5%.[32]

Section 3: Overcoming Industry Hurdles

Industry Hurdle: Sizing the System and Capacity

Distributed renewable energy providers face a challenging business proposition in attempting to project local demand and system capacity.[33]

Solution: Mlinda takes a quantitative approach to ensure its services fit the community's needs. Mlinda analyzes and forecasts productive and domestic loads within specific geographical parameters and uses this information to size their systems. They also provide enough capacity to meet demand growth for three years. While this raises capital cost, it provides a better customer experience and allows for unconstrained economic development.

Industry Hurdle: Sustaining Electricity Demand

Reliable electricity, in itself, is insufficient to sustain or increase electricity demand. Energy services need to be coupled with capacity development initiatives that can help households increase their incomes. Distributed renewable energy tariffs are significantly higher than grid-connected electricity tariffs, which are subsidized. This price difference has impeded the adoption of mini-grid power.[34] Rural customers often have constraints in their ability to pay for higher distributed renewable energy tariffs, especially when electricity services are not paired with opportunities to enhance income-generating activities, such as promoting productive use loads. Distributed renewable energy providers that have focused solely on electrification have experienced low demand.[35]

Solution: Mlinda has adopted a business model that expands beyond energy distribution and transmission—it focuses on capacity development efforts. Mlinda determines the tariffs based on a "willingness-to-pay for reliable power supply" exercise with the community. Mlinda finances soft loans for community members to purchase energy-efficient appliances and retrofits existing diesel appliances to electric use. They also work with communities to secure water for irrigation and assist in getting local crops to the market. Appliance usage, especially the use of productive load appliances such as mills, pumps, and sewing machines, has improved household incomes.[36] The use of these appliances has strengthened household's ability to pay for electricity and has helped Mlinda secure a stable energy demand. Mlinda prioritizes promoting agro-systems and micro-enterprises to sustain energy demand.[37] Even amidst the COVID-19 pandemic, rural customers' energy demand has not waivered, providing another example of how increasing local entrepreneurial development can yield a consistent energy demand.[38]

Industry Hurdle: Tariff Pricing and Regulation

The dichotomy between mini-grid tariffs and tariffs offered by national grids is stark. For instance, grid electricity tariff in Jharkhand was ₹5.75 ($0.07)/kWh for rural domestic consumers and ₹6 ($0.08)/kWh for rural commercial consumers in 2020, whereas mini-grid tariffs can be 3 to 7 times higher.[39] These high tariffs are due to the fact that distributed renewable energy providers need to balance recouping capital and operating costs and charging a price that customers can pay. Mini-grid deployment requires substantial investments –

PV solar cells, batteries, and construction fees. Mini-grid providers in India receive no operational subsidies, as opposed to state-owned DISCOMS. Without grants or government incentives, distributed renewable energy providers need to recoup costs by charging cost-reflective tariffs that are often higher than the national grid electricity tariffs.

Reliable lighting is provided for a household in Jharkhand, India through solar mini-grid power
Source: Mlinda, 2019

Solution: To qualify as a private provider, Mlinda has sought only private funding.[40] Therefore, it can charge a tariff above the India national grid prices.[41] The current daytime tariff is around ₹22 ($0.32)/kWh, and the night-time tariff is around ₹44 ($0.64)/kWh.[42] The price disparity between day and night-time tariffs is due to the cost of storage. Since mini-grids rely upon solar generation, the cost of generating electricity during the day is significantly less. Storage is an expensive operation element, and Mlinda must supply night-time loads using battery storage or diesel generators, which add to the operational costs. Innovative financing, scaling capacity, and supportive policy measures will be essential drivers to help bring down tariff costs and ensure distributed renewable energy is not strictly a premium service that only some users can afford.

Mlinda provides reliable energy services; even villages with a grid connection and access to less expensive power have been shown to sustain their demand for distributed renewable energy. In these villages, Mlinda offers something the grid cannot: a 24/7 energy supply that meets the community's livelihood and household needs; local services and assistance that improves incomes; and measures that help reduce energy poverty.

Mlinda also works with the community to power income-generating activities, thereby improving their customers' ability to pay. They provide training on the use of appliances for economic activities and offer appliance leasing programs to enhance local entrepreneurs' capabilities. Mlinda has focused on customer engagement which has enabled the company to improve the average revenue per user (ARPU) gradually. While Mlinda has so far been successful in navigating the challenges of higher tariffs, policies that help bring down capital costs can make distributed renewable electricity more affordable for households.

Industry Hurdle: Risk of Grid Expansion

One of the risks distributed renewable energy providers face is the liability of stranded assets if the national grid arrives or if grid reliability improves in the villages serviced by the mini-grid provider.[43]

Solution: By working in collaboration with the state and national governments' electrification efforts, distributed renewable energy providers can reduce business risk and either complement or interconnect with the national grid power supply. Mlinda provides power to both off-grid communities and grid-connected communities with intermittent power supply.[44] Mlinda is a certified "Rural Energy Service Provider" with the Ministry of New and Renewable Energy (MNRE).[45] Mlinda has worked with MNRE and Jharkhand Renewable Energy Development Agency (JREDA) to coordinate its distributed renewable energy expansion. India has achieved national electricity grid expansion through targeted policies. However, various state power

DISCOMS struggle with unreliable supply, transmission losses, worsening financial health, and network maintenance difficulties. For such distressed DISCOMS, reliably servicing new, often low-paying, connections acquired through the Indian government's electricity for all programs will be challenging. In such a situation scaling the use of Mini-grids can represent a mutually beneficial solution to all actors—state and central governments, power distributors and generators, and communities.[46]

Industry Hurdle: Political Support

Mini-grids are most successful when they have governmental support.[47] The off-grid energy space is a nascent market; technology costs are high. Without policies that foster off-grid energy development, distributed renewable energy providers have struggled to become self-sustaining. Integrating off-grid solutions with national efforts to improve electricity quality and reliability will be especially important when or if the central government begins efforts to privatize state-owned DISCOMS.[48]

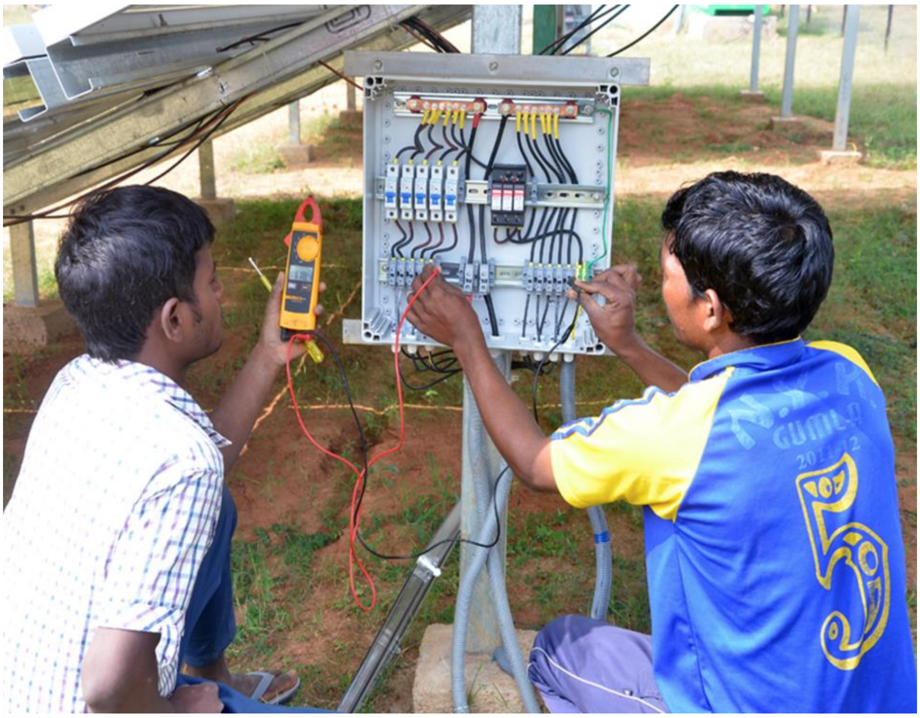
Solution: Supporting distributed renewable energy providers with a community development focus can help strengthen national and state governments' efforts to improve reliable electricity access to meet rural needs, create jobs, and promote local economic development. Additionally, community mini-grids have local operations staff that enables these providers to address supply disruptions and any issues that may occur, ensuring reliability.

Over the years, Mlinda has developed strong ties with JREDA.[49] Mlinda serves as a complementary solution to grid power in Jharkhand. They have been an instrumental stakeholder working with the Jharkhand State Electricity Regulatory Commission (JSERC) to establish and strengthen the Draft Mini-Grid Policy 2018 for Jharkhand.[50] This policy aims to offer clear regulatory guidelines for mini-grids to strengthen decentralized renewable energy growth opportunities in the state.[51] Uttar Pradesh enacted a similar policy in 2016. The Uttar Pradesh Mini-grid-Policy outlines a flexible tariff structure and identifies areas eligible for mini-grid development.[52] Since creating this policy, private mini-grid providers have been able to work in parallel with Uttar Pradesh Power Corporation Limited (UPPCL) to provide greater energy security in the state. Supportive regulatory policies outlining licensing procedures, tariff guidelines, and grid interconnection stipulations can reduce costs and scale mini-grids.[53]

Community mini-grid installed in Sahtioli village
Source: Mlinda, 2019

Section 4: Mlinda's Jobs Impact

Mlinda is continuing to expand its operations. In 2016, it was in a pilot phase with only two mini-grids deployed. As of January 2021, Mlinda manages 45 mini-grids. Thus far, they have connected nearly 7,000 households to their community mini-grid network, providing electricity to 35,000-40,000 people.[54] In addition to managing and deploying mini-grids, Mlinda has an ancillary business that runs community mustard oil expeller operations. Through this work, Mlinda has created market linkages for communities' mustard oil.



Mini-grid operator and engineer test the mini-grid power supply
Source: Mlinda, 2019

Figure 1: Mini-Grid Project Phases and Jobs (for a 25 kW Capacity Mini-Grid)

Design & Pre-construction	**Site Survey, Design, Land Accusation** - Duration: 1 to 1.5 months - Staff member involvement: 2 to 3 field office staff members conduct surveys and manage logistics for land accusation and procurement
Construction & Commissioning	**Building Modular Gird and Powerhouse** - Duration: 1 to 2 months - Number of short-term contractual jobs: 10 to 15 Jobs (local construction contractors) - Staff member involvement: 2 to 3 field office staff members manage and oversee construction **Pole Erection and Distribution Lines** - Duration: 1 to 1.5 months - Number of short-term contractual jobs: 7 to 8 Jobs (local construction contractors) - Staff member involvement: 2 to 3 field office staff members manage and oversee construction **Connections and Household Wiring** - Duration: 1 month, runs parallel with construction and commissioning. - Staff member involvement: Mlinda field office team does the final house wiring and cabling.
Logistics & Management	**Logistics and Management** - Mlinda has an in-country office in Gumla, Jharkhand, where personnel oversee accounts, design, procurement, and operations - Number of full-time employees: 30 to 40
Operations & Maintenance	**Operations and Maintenance** - Duration: the lifetime of a community mini-grid - Number of direct full-time jobs: 3 to 5 *(1 on-site engineer, 1 operator, 1 community operations manager, 0-2-night security guards, dependent upon location)*

Source: Mlinda data[55]

Job Creation

Mlinda's mini-grid expansion efforts have created direct, indirect, induced, and productive use jobs (Appendix A). This case-study estimates direct jobs and productive use jobs.

Direct jobs are earnings and output attributed to the design, installation, and maintenance of mini-grid projects.[56] Upon completion, a community mini-grid will employ 3 to 5 individuals full-time.[57] Direct short-term contractual jobs are created during the deployment and construction of community mini-grids, and these jobs are contracted for only the duration of construction.

Mlinda also supports, enhances, and establishes local livelihoods; these jobs are classified as productive use jobs. Productive use jobs are new and enhanced entrepreneurial jobs that stem from mini-grid electricity and include jobs from mechanization and electrified small businesses. Productive use jobs are variable and can differ by location. This case study does not include the use of irrigation pumps by farmers in the productive use jobs figures (see Appendix A for detailed jobs definitions).

The number of jobs created from Mlinda's mini-grid deployment efforts is summarized in Figure 2 and detailed in Appendix B.1. Based on our projections, Mlinda's community mini-grid deployment efforts have created an estimated 986 full-time equivalent (FTE) jobs, on average from 2016-2020. The number of direct and productive use jobs created from each mini-grid ranges from 15-28 due to each mini-gird's size, the number of connections, and the uptake of productive use loads (see Appendix B.1 for specific calculation details).[58]

Figure 2: Employment Estimates from Mlinda's Mini-Grid Deployment

Job Type	Estimated Jobs Created
Direct Permanent Fulltime Jobs	135 FTE to 225 FTE
Direct short-term contractual jobs *Converted to FTE value*	112 FTE to 151 FTE
Productive Use Jobs	450 FTE to 900 FTE
Total Full-Time Equivalent Jobs (FTE)	**697 FTE to 1276 FTE**

Source: NRDC-CEEW-SCGJ estimates based on Mlinda data, 2019[59]

Note: All values are shown as full-time equivalent jobs; the jobs figures in this table represent the number of jobs across Mlinda's entire mini-grid portfolio (45 mini-grids at the time of this report)

Livelihood Impact for Farmers

Improved energy access can create livelihood improvements, specifically for farmers. In villages where Mlinda operates, most households rely on agriculture for either subsistence farming or income generation. Access to reliable electricity has enabled these farmers to transition from using diesel pumps to efficient electric pumps for irrigation.

To improve their access to irrigation, Mlinda supports farmers in three ways. First, Mlinda connects the village in which it operates to irrigation sources such as reservoirs or canals. Second, Mlinda establishes ties with vetted suppliers of efficient pumps and offers farmers credit to purchase electric pumps, if required. Third, Mlinda has established a pump borrowing system. Mlinda loans pumps to farmers (at no additional costs), and farmers simply pay the incurred energy costs for running the electrical pump.[60] These arrangements benefit both parties—farmers receive access to efficient electric pumps to irrigate crops and boost agricultural productivity. At the same time, Mlinda secures a reliable daytime energy load when the cost of electricity generation is low.

Farmers can now irrigate their fields with electric powered pumps
Source: Mlinda, 2019

Creation of New Entrepreneurial Jobs

Mlinda helps community members buy energy-efficient appliances and acts as an intermediary with appliance wholesalers assisting with appliance delivery and coordination. In some instances, Mlinda also provides micro-financing so that community members can purchase appliances such as rice-hullers and millers.[61] Mlinda helps these entrepreneurs and farmers establish market linkages to sell their products. Efforts to increase productive use loads and appliance access have created new entrepreneurial jobs and have increased Mlinda's productive use loads.

Mini-grids power productive use loads like grain mills
Source: Mlinda, 2019

One of Mlinda's key operational success metrics is community gross domestic product (GDP) growth. Mlinda invests a considerable amount of time and resources in developing skills and building capacity within rural communities so that electricity services can be utilized to spur local economic growth.[62] Mlinda has partnered with Sambodhi, a third-party auditor, to conduct bi-annual impact assessments. These assessments aim to measure the effect community mini-grids have on local GDP, carbon emission reductions, and livelihood gains. The results are depicted in Figure 3.[63]

Figure 3: Mlinda's Livelihood Impact Summary (2018)

Reliability	• Mlinda provided access to reliable, 24/7, renewable energy for 948 homes and 213 agricultural and other small business uses
Increase Revenue Generation	• The GDP per capita has increased by 7.3% • The energy efficiency of GDP has increased by 115.6%
Reduced Emissions	• Greenhouse gas emissions have reduced by 1054 metric tons per year
Livelihood Improvements	• Women surveyed stated they spend less time on domestic chores and more time on productive activities • Children can study for longer periods under less harmful lighting

Source: Mlinda[64]

Mlinda Impact Spotlight: Sahitoli Village

Sahitoli, a hilly village in Jharkhand's Gumla district, was without grid-connected electricity. Before Mlinda started working there, the village depended on diesel generation and kerosene for lighting.
In April 2018, Mlinda built a 22.4 kWp solar-powered mini-grid and worked with community members to transition Sahitoli from diesel and kerosene to clean energy. Mlinda has worked with the community of Sahitoli to convert several diesel-based pumps, rice hullers, and millers to electric-based use, which has helped provide additional sources of income. The community mini-grid deployment in Sahitoli created 18 jobs through direct employment and entrepreneurial jobs that resulted from productive use loads.[65]

Mlinda prioritized building community capacity and worked with farmers to develop, sustain, and increase electricity usage. Mlinda was able to extend mini-grid connections to the Chandal dam, a location just outside of the village where most farms pump water to irrigate their lands—extending the connection led to sustained agricultural energy usage for irrigation and increased crop production.[66] Mlinda also helped Sahitoli produce value-added products by supporting an initiative to use oil expeller units to process mustard oil. Processing the mustard seeds to oil has helped increase the mustard crop demand, and Mlinda has helped create market linkages for the communities' mustard oil.

Livelihood Impact from the Sahitoli Village Community Mini-grid (2019) [67]

- Connected Households: 124
- Productive loads: 19 small pumps, 3 rice hullers, 2 wheat mills, and 2 shops
- Jobs Created: 18 direct full-time and productive use jobs
- Average Income Increase: 10% to 15%
- GDP per capita Increase: 10.6%

Sahtioli villagers irrigate fields with electric pumps powered by solar mini-grid
Source: Mlinda, 2019

Section 5: Spread of Distributed Renewable Energy Providers in India

Mini-grids are a promising distributed renewable energy technology and have the potential to become commercially viable in India.[68] Mini-grids offer a direct pathway towards providing high-quality electricity to rural communities and provide a gateway for additional income generation. State governments such as Uttar Pradesh and Jharkhand show that mini-grids will play a key role in increasing rural electricity use and reducing energy poverty. International players are also helping drive mini-grid development in India; organizations such as the Rockefeller Foundation, Engie's impact investment fund, and others have helped finance several mini-grid projects in India.[69]

Smart Power India

The Rockefeller Foundation supports Smart Power India (SPI), and thus far, electrification efforts through mini-grids have been deployed in Bihar, Uttar Pradesh, and Jharkhand. To date, SPI has developed 300 renewable energy mini-grids, installing 9.2 MW of capacity.[70]

Before Smart Power India (SPI) began deploying its mini-grid portfolio, SPI analyzed two business models for mini-grid deployment. One utilized an anchor-based approach and the other a non-anchor-based approach.[71] An anchor-based system is where the mini-grids are deployed to a region with a large baseload, such as a telecommunication tower; while a non-anchor-based approach is more community-centric, focused on developing local productive use loads.[72] After analyzing how these two approaches affected household revenue and income generation, Smart Power India turned to a non-anchor-based model, and focused on pairing energy services with development services. Their adopted community-centric model focuses on building local economies' demand for power by supporting income-generating activities.[73]

Smart Power India Socio-Economic Impact (2017) [74]

- **Creating new business opportunities:** The arrival of reliable mini-grid power resulted in a 7% increase in operating businesses
- **Expansion of existing business:** Of existing micro-enterprises, 11% purchased appliances
- **Increased Incomes:** Micro-enterprises reported a 12% to 15% increase in monthly revenues.
- **Health Benefits:** Of the households surveyed, 23% switched entirely to electric lighting, eliminating diesel and kerosene usage and improving household air quality
- **Increase Access to Essential Services:** Mini-grid electrified communities have increased the hours of operations for facilities, such as markets and healthcare facilities

Solar mini-grid in India
Source: Smart Power India, 2018

TATA Power and The Rockefeller Foundation

The Rockefeller Foundation has partnered with Tata Power, India's largest integrated power company, to deploy 10,000 mini-grids across India.[75] The new venture called TP Renewable Microgrid was launched in November 2019 and will develop 10,000 mini-grids over the next seven years in Bihar and Uttar Pradesh.[76]

TP Renewable Microgrid plans to deploy a "Utility-in-a-Box" modular mini-grid system that can be deployed and adopted to meet a community's energy demand. The mini-grid system comes pre-assembled with all hardware, which has enabled TP Renewable Microgrid to decrease their overall capital costs by 23% and reduce the installation time by 80%.[77] The company is focused on making its business model commercially viable and is looking to supply clean, abundant, and affordable electricity across rural India.

Mini-grid plant operator checks battery charge in mini-grid power house
Source: Mlinda, 2019

TP Renewable Microgrid aims to connect 5 million households and 25 million people with distributed renewable energy. They estimate that their electrification efforts will power 10,000 rural enterprises, create 10,000 new green jobs, and provide irrigation for over 400,000 local farmers.[78] TP Renewable Microgrid will own and operate each community mini-grid, and the Rockefeller-backed Smart Power India will provide technical expertise. Smart Power India will help ensure that both energy and development services are offered to connected communities by providing business development support and ancillary services to sustain local economic growth.[79]

Husk Power Systems

Husk Power Systems designs, builds and operates hybrid power plants in Bihar and Uttar Pradesh. Their business model is focused on community engagement, and they work to ensure that villagers are trained to manage and operate their Solar PV and biomass generation systems. Currently, Husk Power Systems operates over 75 mini-grids with a total installed capacity of over 1.75 MW. They estimate that their electrification efforts have created 125 direct full-time jobs and 80 additional part-time productive use jobs.[80] Husk Power Systems operates under a business model focused on providing reliable 24/7 electricity services to meet the needs of households, community facilities, small businesses, and factories.

Solar Mini-Grids Drive Socio-economic Growth in South Asia

Solar mini-grids have been shown to drive socio-economic growth and can provide a low-cost solution for increasing energy access. The Mini-grid Investment Accelerator estimates that 44% of new energy connections in developing Asia will be through mini-grid power.[81] If executed well, mini-grids can be an attractive means for rural electrification and present an opportunity to spur new income-generating actives in electrified rural communities.

National electrification plans across the developing world are beginning to incorporate mini-grids to service last-mile connections. Countries throughout South and South-East Asia have adopted specific policies and initiatives to spur broader mini-grid development.[82] For example, Indonesia has recently updated its national development plan. The plan outlines how mini-grids play a significant role in reaching off-grid electrification goals and are critical to providing reliable electricity access to remote villages.[83]

Auko Energy, one of a handful of distributed renewable energy providers in the region, formed a partnership with the Millennium Challenge Account to develop an extensive 1.2 MW mini-grid network in Indonesia. Local communities own the mini-grids, and Akuo Energy helped train local staff to maintain and operate the mini-grids. Akuo Energy has supplied electricity to power productive use loads such as shops, chillers, and pumps and has helped connected communities shift away from diesel reliance.[84]

In Myanmar, decentralized electrification is a crucial aspect of Myanmar’s National Electrification Program 2015 (NEP).[85] Yoma Micro Power, a prominent distributed renewable energy provider in Myanmar, has deployed over 250 solar PV-hybrid mini-grids across the country.[86] Yoma works closely with the communities it services and has established public-private partnerships to increase its projects’ sustainability and success.[87]

Mini-grid development has also begun to expand across Nepal and Bangladesh. One prominent mini-grid developer in Bangladesh, Rahima Renewable Energy, has adopted a development model that focuses on building local enterprises’ demand for power.[88] Their deployment of an 80 kWp solar PV-hybrid mini-grid was paired with efforts to promote income generation from agro-processing activities. Based on Rahima Renewable Energy’s assessment, productive work engagement increased by 33% since the community mini-grid deployment.[89]

In Nepal, Gham Power has adopted a distributed renewable energy system to fit Nepal’s local context. Gham power installed a network of “mini-mini-grids” in Nepal’s hilly eastern region and has worked to integrate productive use appliances at project sites. Part of its services model included hosting workshops on productive electricity end-use. The firm estimates that 200 entrepreneurial jobs have been created from mini-grid electricity use in Nepal.[90]

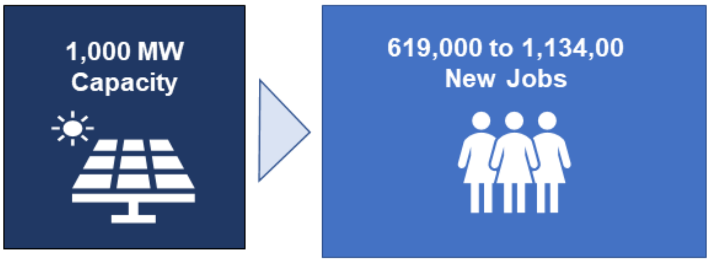
Section 6: New Opportunities Ahead

This case study highlights an inclusive electricity and development services model that can yield benefits for both communities and distributed renewable energy providers. Using such a model to scale mini-grid deployment can help improve rural livelihoods, create jobs, and reduce income and energy poverty.

Job Growth Prospects

MNRE launched *Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyaan* (PM KUSUM) in 2019 to promote decentralized grid-connected solar mini-parks (Component A) and off-grid and grid-connected solar pumps (Component B and C, respectively) in rural areas. The program aims to add 10,000 MW of grid-connected small/micro solar or other renewable source-based generation by 2022 with an initial target of 1,000 MW.[91]

Meeting the initial 1,000 MW target by deploying mini-grids that follow an "energy services and development-based" business model, similar to Mlinda, could create 619,000 to 1,134,000 jobs. The number of jobs created from Mlinda's business model is similar to the industry. Mini-grid providers that have adopted a business model that incorporates both energy services and capacity development initiatives have created and sustained a similar number of jobs to Mlinda. Based on information gathered from case studies across South Asian a comparable projected job average estimate was derived—800,000 jobs could be created for 1,000 MW of installed mini-grid capacity. The number of jobs, particularly productive use jobs, differs based on the type of business model, uptake of productive use loads, and geography (see Appendix B for the detailed calculation methodology).



Skill Development

Mini-grid projects can create new jobs in India's rural areas, which go beyond the agricultural sector. Distributed renewable energy providers often work in remote geographies where there can be a shortage of skilled workforce. Designing targeted training and skill development programs at regular intervals is key to addressing the scarcity of skilled workers in the sector. Skills development trainings organized by distributed renewable energy providers can complement state and other institutions training offerings.

Inputs from distributed renewable energy providers suggest a continuous need to train plant operators and provide refresher-training programs across the project life cycle. Training programs can improve the community's capacity and significantly increase the participants' employability in associated sectors. Once trained, skilled local plant operators can draw upon their project management experience and technical skills to shift to other entrepreneurial jobs. Two Qualification Packs developed by SCGJ, namely SGJ/Q0111: Solar PV Project Helper and SGJ/Q0118: Solar Off-Grid Entrepreneur, focus on developing skills pertaining to mini-grid installation and associated entrepreneurship actives.[92] Partnerships between civil society groups like the SCGJ and local distributed renewable energy providers are critical to promoting broader skill development, increasing the skilled workforce, and enhancing local entrepreneurs' capacities.

Powering livelihoods and reducing energy poverty requires a coordinated approach. A public-private partnerships model could help establish a mini-grid interconnection framework that benefits both the public and private sectors.[93] With states and DISCOMs facing mounting debt, the ability to improve rural electricity reliability is likely to be constrained. In specific contexts, distributed renewable energy solutions such as community mini-grids can be an effective and reliable alternative to grid electricity.[94]

Pairing electricity services with other initiatives can promote rural enterprise development, improve villages' resilience to natural disasters, and enhance the reliability of healthcare, which is especially critical during the COVID-19 pandemic.

A large portion of India's rural population does not have access to reliable power. While the extension of reliable electricity services is critical, access to energy alone cannot steer rural economic growth. Experiences of distributed renewable energy providers highlighted in the case study exemplify that complementing energy services with skill development, connection to markets, and financing can benefit both the distributed renewable energy provider and the community. These efforts have helped rural communities sustain entrepreneurial activities such as grain milling and food processing. Mlinda and the other distributed renewable energy providers included in this case study have showcased that mini-grids are a viable solution to bridge the rural energy accessibility gaps and create jobs.

Appendix A: Jobs Definitions

A.1 Jobs Description

- **Direct jobs:** include permanent and short-term contractual jobs associated with the design, management, construction/installation, and maintenance of projects. Mini-grids create direct full-time jobs in the design and maintenance, and operations phases of the project.
- **Direct short-term contractual jobs:** are created in the design and construction period and typically last three to four months.
- **Productive use jobs:** are those created by the end-users of the mini-grids. In this case study, productive use jobs are existing and new entrepreneurial jobs that have been enhanced due to the use of mini-grid electricity. Some examples of productive use jobs include those from electrified rice-hulling machines, cold storage units, oil expellers, grain-milling machines, air compressors, sewing machines, shops, and welding machines**.** Productive use jobs can vary significantly based on the geography, the business model of mini-grids, and operators.
- **Indirect jobs:** are related to the manufacturing of equipment and materials used in the project, the supply chain that fabricates and delivers these materials, and the finance and banking sectors that provide services for the construction and operation of a project. This case-study does not estimate indirect jobs.
- **Induced jobs:** are jobs created due to expenses by people directly or indirectly employed by the projects. This case-study does not estimate induced jobs.

A.2 Short-term Contractual Jobs vs. Full-time/Permanent Jobs Explanation

The construction and deployment of mini-grids create short-term contractual jobs spanning approximately one month to four months (i.e., pre-construction, modular gird installment, powerhouse construction, pole erecting, and wiring). Once the project is completed, those functions are no longer needed, and the workforce employed for those functions moves on to the next project. For the last phase of the project (i.e., operations and maintenance), the employment lasts for the project's lifetime, and those jobs are direct full-time jobs.

Appendix B: Jobs Analysis

B.1 Mlinda Jobs Analysis

Mlinda provided the job data used in this analysis; all employment information was collected through an interview with Gaurav Pandey, Head of Operations at Mlinda. The data outlined in Table B.1.1 is organized on a per-project basis.

Table B.1.1: Mlinda Jobs per Mini-grid

Per Mini-grid Employment	Jobs
Direct Full-Time Jobs	3 to 5
Direct Short-Term Contractual Jobs	10 to 15 and then 7 to 8
Productive Use Jobs	10 to 20

Source: Mlinda[95]

Employment ranges provided by Mlinda were used to calculate a low and high total job estimate. The total fulltime equivalent job coefficient was then derived for direct short-term jobs to depict the number of annual jobs created from contractual work. The lower-ranging job values are multiplied by the number of projects to derive a low estimate for the number of total jobs. The higher ranging job values were multiplied by the number of projects to obtain a high estimate. Averaging the two total estimates, Mlinda has created an estimated 986 jobs to date. Dividing the total number of jobs created by Mlinda by the installed capacity (the number of mini-grids deployed 45 multiplied by the average mini-grid size 25 kWp) a job/kWp ratio was calculated and depicted in Table B.1.2. Since this case study focuses on the "energy services and development model" for mini-grids, we include productive jobs in the jobs/kWp calculations.

Table B.1.2: Mlinda Mini-grids Jobs (Direct, Indirect, and Productive Use Jobs)

Mlinda Project Information		
Number of Mini-grids deployed		45
Total capacity (kW)		1,125
Total Jobs	**Low Estimate**	**High Estimate**
Direct full-time jobs	135	225
Full-time equivalent jobs from part-time construction jobs over 3 to 4 month period)	112	151
Indirect livelihood jobs	450	900
Total Fulltime Equivalent Jobs (FTE)	697	1276
Mlinda job/kWp (With Productive Use Jobs)	0.62	1.13
Mlinda's Average Job Values	**Average Estimate**	
Average FTE Job total (With Productive Use Jobs)	986	
Average Mlinda job/kWp (With Productive Use)	0.877	
Average FTE job total (Without Productive Use Jobs)	311	
Average Mlinda job/kWp (Without Productive Use Jobs)	0.277	

Source: NRDC-CEEW-SCGJ estimates based on Mlinda [96]

B.2 Tata Power and Rockefeller Foundation Projected Jobs Analysis

Additional case studies were compiled for this report to compare the figures obtained by Mlinda to other mini-grid development efforts. The case-study draws upon information from the Tata Power and the Rockefeller Foundation's 10,000 mini-grid initiative. This program published publicly available job statistics, forecasting that one direct job and ten new entrepreneurial jobs would be created per mini-grid. However, actual on-the-ground experience may vary. The average grid capacity used for the analysis is 25kWp.[97]

Based on this information, the estimated average job/kWp ratio is 0.44. The job numbers outlined in Table B.2.1 represent the average number of jobs created per project; thus, some mini-grids may exceed or fall short of these averages. Information on short-term contractual jobs was not available, and short-terms jobs were not included in Table B.2.1 or in the calculated job/kWp ratio. The job/kWp ratio is based on only direct full-time jobs and productive use jobs.

Table B.2.1: Tata Power & Rockefeller Foundation Jobs (Direct and Productive Use Jobs Only)

Job Type	Jobs per Mini-grid
Direct Fulltime Jobs	1
Productive Use Jobs	10
Average Job/kWp	0.44

Source: Tata Power and Rockefeller Foundation [98]

B.3 South Asia Mini-grid Jobs Analysis

The Alliance for Rural Electrification published a detailed report highlighting the business models and livelihood impacts of several distributed renewable energy providers in South Asia. Jobs figures and capacity sizes for each PV-hybrid solar mini-grid project were compiled from this report to derive a job/kWp ratio for each project. The projects listed in table B.3.1 provide a comparable reference for India's mini-grid deployment efforts. These solar PV-hybrid systems have a similar capacity, and the locations where these mini-grids have been deployed have socio-economic characteristics analogous to rural India. Based on the compiled jobs figures listed in Table B.3.1 the number of jobs created from mini-grid deployment efforts across South Asia has resulted in a similar number of jobs to Mlinda's mini-grid development efforts. Of the solar min-grid systems assessed in this report, each mini-grid deployed created between 20 to 60 direct and productive use jobs, and the calculated jobs/kWp ratio was within 10% of the reported jobs/kWp ratio extrapolated from Mlinda job data.

Table B.3.1: South Asia Solar PV-Hybrid Solar Mini-grid Jobs (direct and productive use jobs only)

Project	Location	Size of mini-grid (kWp)	Jobs Created	Jobs/kWp
Rahimafrooz Renewable Energy	Ghorjan Island Bangladesh	80	60	0.8
Tara Urja	Derni, India	31.2	43	1.4
Madalay Yoma	Dee Doke Myanmar	55	23	0.4
Yoma Micro Power	Myanmar	31.2	20	0.6
Job/kWp Average				0.80

Source: Alliance for Rural Electrification (2019)[99]

B.4 Jobs Projection with 1,000 MW of Additional Mini-grid Capacity

MNRE's *Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyaan* program (PM KUSUM), aims to add 10,000 MW of grid-connected small/micro solar or other renewable source-based generation by 2022 with an initial target of 1,000 MW.[100] If the initial 1,000 MW capacity target is met through the deployment of mini-grids that follow Mlinda's "energy services and development-based" business model an estimated average of 877,000 jobs could be created. By extrapolating data from published South Asian mini-grid case study's a comparable projected job average estimate was derived—800,000 jobs could be created for 1,000 MW of installed mini-grid capacity. The number of jobs particularly productive use jobs differs slightly based on the type of business model, uptake of productive use loads, and geography.

Table B.4.1: Estimated Jobs Created with 500 MW and 1,000 MW Targets Based on Experiences of Different Mini-Grid Providers

	Tata Power / Rockefeller	South Asia	Mlinda (Avg)	Mlinda (Low)	Mlinda (High)
Jobs/ kWp	0.44	0.80	0.877	0.62	1.13
Estimated Jobs at 500 MW capacity	220,000	400,000	438,500	310,000	567,000
Estimated Jobs at 1,000 MW capacity	440,000	800,000	877,000	619,000	1,134,000

Source: NRDC-CEEW-SCGJ estimates based on 2019-2020 data from Mlinda, Tata Power and Rockefeller Foundation, and The Alliance for Rural Electrification[101]

Endnotes

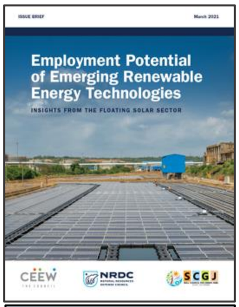
[1] Rockefeller Foundation, *Expanding Opportunities for Renewable Energy Based Mini-Grids in Rural India*, April 2017.
[2] Pandey, G., Phone Interview, November 2020; CEEW, NRDC, *Powering Jobs Growth with Green Energy*, July 2019; This jobs figure represents the total number of jobs created from Mlinda's 45 mini-grids deployed to date. Mini-grids can create direct jobs, indirect jobs, and productive use jobs. Direct jobs include permanent and short and long-term contractual jobs associated with the design, development, management, construction/installation, and maintenance of projects. Productive use jobs are those created by the end-users of the mini-grids. In the case study, productive use jobs are defined as new or enhanced entrepreneurial jobs. Productive use jobs will vary across locations and operators. These figures were obtained from Mlinda directly and then extrapolated based on the number of mini-grids deployed.
[3] Pandey, G., Phone Interview, November 2020.
[4] The number of jobs will vary based on geography, business model, size of system, and the operator.
[5] The number of jobs will vary based on geography, business model, size of system, and the operator.
[6] MNRE, *Pradhan Mantri Sahaj Bijli Har Ghar Yojana*, October 2017. https://saubhagya.gov.in/assets//download/OM-SAUBHAGYA%20(SIGNED%20COPY).pdf (Accessed Oct. 26, 2020).
[7] IEA, "India 202 Energy Policy Review," https://www.iea.org/reports/india-2020https://www.iea.org/reports/india-2020 (Accessed Oct. 26, 2020).
[8] Rockefeller Foundation, Smart Power India, Initiative for Sustainable Energy Policy, *Rural Electrification in India – Customer Behavior and Demand,* February 2019, https://www.rockefellerfoundation.org/report/rural-electrification-india-customer-behaviour-demand/https://www.rockefellerfoundation.org/report/rural-electrification-india-customer-behaviour-demand/ (Accessed Nov. 5, 2020).
[9] Joshi, M. et al., *SEWA-NRDC Green Villages – Advancing Clean and Energy Efficient Solutions to Improve Livelihoods*, 2020; NRDC et al., India Residential Energy Survey (IRES), https://www.ceew.in/india-residential-energy-survey-ires (Accessed Oct 27. 2020).
[10] New Ventures Asia, Miller Center For Social Entrepreneurship, "Energy Access Investment Readiness Program: Does your electrified village need a microgrid," https://www.youtube.com/watch?v=teseLgaTiqI#action=sharehttps://www.youtube.com/watch?v=teseLgaTiqI#action=share(Accessed Oct. 26, 2020).
[11] Sharma, A. et al., *The Adoption and use of Solar Mini-grids in Gird-Electrified Indian Villages,* ISEP, February 2020.
[12] NREL, "Opportunities and Challenges for Solar Mini-grid Development in Rural India," https://www.nrel.gov/docs/fy12osti/55562.pdfhttps://www.nrel.gov/docs/fy12osti/55562.pdf (Accessed Nov. 5, 2020).
[13] Power for All and CEEW, *Powering Jobs Census 2019: Focus on India,* https://www.ceew.in/sites/default/files/Powering-Jobs-Census-2019-India_CMYK_print_0.pdf (Accessed Nov. 5, 2020); Rockefeller Foundation, *Expanding Opportunities for Renewable Energy Based Mini-Grids in Rural India*, April 2017.
[14] Rockefeller Foundation, Smart Power India, *Rural Electrification in India – Customer Behavior and Demand,* Feb. 2019.
[15] NREL, "Opportunities and Challenges for Solar Mini-grid Development in Rural India," https://www.nrel.gov/docs/fy12osti/55562.pdfhttps://www.nrel.gov/docs/fy12osti/55562.pdf (Accessed Nov. 5, 2020).
[16] NREL, "Opportunities and Challenges for Solar Mini-grid Development in Rural India," https://www.nrel.gov/docs/fy12osti/55562.pdfhttps://www.nrel.gov/docs/fy12osti/55562.pdf (Accessed Nov. 5, 2020).
[17]Aparna, K. et al., *Sustainability of Community-owned Mini-grids: Evidence from India*, January 2019
[18] Shonali, P. et al., *Global Energy Assessment – Toward a Sustainable Future,* Energy Access for Development 2012, Ch. 19, pg. 1401-1458.
[19] IREDA, "Renewable Mini-Girds: Innovation Landscape Brief," https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/Sep/IRENA_Renewable_mini-grids_2019.pdf?la=en&hash=CFE9676B470A96F7A974CB619889F5810A06043E (Accessed Oct. 20, 2020)
[20] Mini-Grids Partnership (MGP), *State of the Global Mini-grids Market Report*, 2020.
[21] Mini-Grids Partnership (MGP), *State of the Global Mini-grids Market Report*, 2020.
[22] Mlinda, "The Project," https://www.mlinda.org/democratising-energy-supply/https://www.mlinda.org/democratising-energy-supply/(Accessed Oct. 26, 2020).
[23] Gaurav. P, Interview with Head of Operations at Mlinda, November 2020
[24] Mlinda, "The Project," https://www.mlinda.org/democratising-energy-supply/https://www.mlinda.org/democratising-energy-supply/ (Accessed Oct. 26, 2020).
[25] Mlinda, "Achievements and Performance 2018," https://www.mlinda.org/democratising-energy-supply/activities-2018/ (accessed Jan. 22, 2020); While information regarding household connection commitments is given, data on load factor or percentage of retained customers has not been fully assessed at this time.
[26] Pandey, G., Phone Interview, November 2020.
[27] Pandey, G., Phone Interview, November 2020.
[28] Pandey, G., Phone Interview, November 2020.
[29] Vijay, B., Phone Interview, 2018; A PV-Solar hybrid mini-grid is a system with both battery power and deiseal generation for back-up power.
[30] Mlinda, "The Project," https://www.mlinda.org/democratising-energy-supply/https://www.mlinda.org/democratising-energy-supply/ (Accessed Nov. 5, 2020).
[31] Pandey, G., Phone Interview, November 2020.
[32] Alliance for Rural Electrification, *Private Sector Driven Business Models for Clean Energy Mini-Grids Lessons learned from South and South-East-Asia*, 2019.

[33] World Bank, "Mini-Grids for Half a Billion People: Market Outlook Report'" https://openknowledge.worldbank.org/handle/10986/31926https://openknowledge.worldbank.org/handle/10986/31926 (Accessed Nov. 20, 2020)
[34] Katre, A. et al., *Sustainability of Community-owned mini-grids: evidence from India*, January 2019; Sharma Anjali et al., *The Adoption and use of Solar Mini-grids in Gird-Electrified Indian Villages,* ISEP, February 2020
[35] Sharma, A. et al., *The Adoption and Use of Solar Mini-grids in Gird-Electrified Indian Villages,* ISEP, February 2020
[36] Pandey, G., Phone Interview, November 2020; The rural communities in Jharkhand have average annual household incomes equivalent to less than Rs. 62,00 ($ 850)
[37] Mlinda, "The Project," https://www.mlinda.org/democratising-energy-supply/https://www.mlinda.org/democratising-energy-supply/ (Accessed Oct. 26, 2020).
[38] Pandey, G., Phone Interview, November 2020.
[39] Jharkhand State Electricity Regulatory Commission, *Order on True-up for FY 2016-17& FY 2017-18, Annual Performance Review for FY 2018-19 and ARR & Tariff for FY 2019-20 for Jharkhand Bijli Vitran Nigam Limited (JBVNL),* February 28, 2019, https://jbvnl.co.in/Tariff/Tariff_jseb_2019.pdf (Accessed Feb 2, 2021); The Telegraph, "No Increase in Power Tariffs, Rules State Regulator," October 1, 2020, https://www.telegraphindia.com/jharkhand/no-increase-in-power-tariffs-rules-state-regulator/cid/1793675 (Accessed on Feb 2, 2021).
Statista, "Average cost of state electricity supply across India from the financial year 2009 to 2019" https://www.statista.com/statistics/808201/india-cost-of-state-electricity-supply/
[40] Mlinda, "Mlinda Annual Report," https://www.mlinda.org/wpcontent/uploads/2020/02/Mlinda_Annual_Report_2018.pdf (Accessed Jan 21, 2021).
[41] Stephan, C. et al., *Enabling Mini-grid Development in Rural India*, https://law.stanford.edu/wp-content/uploads/2016/04/IndiaMinigrid_Working_Paper2.pdfhttps://law.stanford.edu/wp-content/uploads/2016/04/IndiaMinigrid_Working_Paper2.pdf (Accessed Oct. 26, 2020)
[42] $1=Rs.70; Alliance for Rural Electrification*, Private Sector Driven Business Models for Clean Energy Mini-Grids Lessons learned from South and South-East-Asia,* 2019.
[43] Stephan, C. et al. *Enabling Mini-grid Development in Rural India*, https://law.stanford.edu/wp-content/uploads/2016/04/IndiaMinigrid_Working_Paper2.pdfhttps://law.stanford.edu/wp-content/uploads/2016/04/IndiaMinigrid_Working_Paper2.pdf (Accessed Oct. 26, 2020).
[44] MNRE, "Renewable Energy Akshay Urja," https://mnre.gov.in/img/documents/uploads/670406a017f54c9386fcde911ee5abe6.pdfhttps://mnre.gov.in/img/documents/uploads/670406a017f54c9386fcde911ee5abe6.pdf (Accessed Oct. 26, 2020): New Ventures Asia, Miller Center For Social Entrepreneurship, "Energy Access Investment Readiness Program: Does Your Electrified Village Need a Microgrid," https://www.youtube.com/watch?v=teseLgaTiqI#action=sharehttps://www.youtube.com/watch?v=teseLgaTiqI#action=share (Accessed Oct. 26, 2020).
[45] Under MNRE's Renewable Energy Service Provider (RESP) program in 2016, approved mini-grid operators were eligible to receive financial assistance from the central government with no restrictions on the consumer electricity tariffs charged; Stephen, C.et al. "Enabling Mini-Grid Development in Rural India," *Working Paper,* July 2016, https://law.stanford.edu/wp-content/uploads/2016/04/IndiaMinigrid_Working_Paper2.pdf (Accessed Nov. 2, 2020).
[46] Institute of Advanced Sustainability Studies (IASS), The Energy and Resource Institute (TERI), *Making the Paris Agreement a Success for the Planet and the People of India. Unlocking the Co-Benefits of Decarbonising India's Power Sector*, 2020.
[47] USAID, "How Should Governments Integrate Mini-grids into National Electrification Planning," https://www.usaid.gov/energy/mini-grids/policy/national-planninghttps://www.usaid.gov/energy/mini-grids/policy/national-planning (Accessed Nov. 5, 2020).
[48]Shirimali, G., "Scaling reliable electricity access in India: A public-private partnership model," https://energy.stanford.edu/sites/g/files/sbiybj9971/f/scaling_reliable_electricity_access_in_india-_a_public-private_partnership_model.pdf (Accessed Oct. 26, 2020).
[49] Vijay, B., Phone Interview, 2018; UKaid, "Energy Catalyst Learning Series, The Future of Decentralized Energy in India: Staying Relevant in a 'Post-Access' Market," https://www.youtube.com/watch?v=AA5EiznNAgk&feature=youtu.be (Accessed Nov. 5, 2020)
[50] CEED, "Proposed Mini-grid policy, an important step towards Power for All initiative," http://ceedindia.org/proposed-mini-grid-policy-an-important-step-towards-power-for-all-initiative/(Accessedhttp://ceedindia.org/proposed-mini-grid-policy-an-important-step-towards-power-for-all-initiative/ (Accessed Nov. 20, 2020).
[51] CEED, "Proposed Mini-grid policy, an important step towards Power for All initiative," http://ceedindia.org/proposed-mini-grid-policy-an-important-step-towards-power-for-all-initiative/(Accessedhttp://ceedindia.org/proposed-mini-grid-policy-an-important-step-towards-power-for-all-initiative/ (Accessed Nov. 20, 2020).
[52] The World Bank, *Mini-Grids in Uttar Pradesh: A Case Study of a Success Story,* 2016.
[53] USAID, "How Should Governments Integrate Mini-grids into National Electrification Planning," https://www.usaid.gov/energy/mini-grids/policy/national-planninghttps://www.usaid.gov/energy/mini-grids/policy/national-planning (Accessed Nov. 5, 2020).
[54] Pandey, G., Phone Interview, November 2020.
[55] Pandey, G., Phone Interview, November 2020.
[56] CEEW, NRDC, *Powering Jobs Growth with Green Energy*, July 2019
[57] Pandey. G., Phone Interview, November 2020

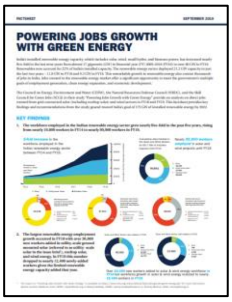
[58] Pandey, G., Phone Interview, November 2020; CEEW, NRDC, *Powering Jobs Growth with Green Energy*, July 2019; This jobs figure represents the total number of jobs created across all 45 Mlinda mini-grids. Mini-grids can create direct jobs, indirect jobs, and productive use jobs. Direct jobs include permanent and short and long-term contractual jobs associated with the design, development, management, construction/installation, and maintenance of projects. Productive use jobs are those created by the end-users of the mini-grids. These figures were obtained from Mlinda directly and were then extrapolated based on the number of mini-grids deployed to date.
[59] Pandey, G., Phone Interview, November 2020.
[60] Pandey, G., Phone Interview, November 2020.
[61] Pandey, G., Phone Interview, November 2020.
[62] UKaid, Energy Catalyst Learning Series, The Future of Decentralized Energy in India: Staying Relevant in a "Post-Access" Market," https://www.youtube.com/watch?v=AA5EiznNAgk&feature=youtu.be (Accessed Nov. 5, 2020)
[63] Mlinda, "The Project," https://www.mlinda.org/democratising-energy-supply/https://www.mlinda.org/democratising-energy-supply/ (Accessed Oct. 26, 2020).
[64] Mlinda, "Annual Report, 2018," https://www.mlinda.org/wp-content/uploads/2020/02/Mlinda_Annual_Report_2018.pdf (Accessed Oct. 26, 2020).
[65] Alliance For Rural Electrification, "Mlinda Foundation 22.4 kWp Solar-Powered Mini-Grid in Shaitoli," 2019, https://www.ruralelec.org/project-case-studies/mlinda-foundation-224-kwp-solar-powered-mini-grid-sahitoli-indiahttps://www.ruralelec.org/project-case-studies/mlinda-foundation-224-kWp-solar-powered-mini-grid-sahitoli-india (Accessed Oct. 26, 2020).
[66]Alliance For Rural Electrification, "Mlinda Foundation 22.4 kWp Solar-Powered Mini-Grid in Shaitoli," 2019, https://www.ruralelec.org/project-case-studies/mlinda-foundation-224-kwp-solar-powered-mini-grid-sahitoli-indiahttps://www.ruralelec.org/project-case-studies/mlinda-foundation-224-kWp-solar-powered-mini-grid-sahitoli-india (Accessed Oct. 26, 2020).
[67] Alliance For Rural Electrification, "Mlinda Foundation 22.4 kWp Solar-Powered Mini-Grid in Shaitoli," 2019, https://www.ruralelec.org/project-case-studies/mlinda-foundation-224-kwp-solar-powered-mini-grid-sahitoli-indiahttps://www.ruralelec.org/project-case-studies/mlinda-foundation-224-kWp-solar-powered-mini-grid-sahitoli-india (Accessed Oct. 26, 2020).
[68] Rockefeller Foundation, *Expanding Opportunities for Renewable Energy Based Mini-Grids in Rural India*, April 2017
[69]Rockefeller Foundation, *Expanding Opportunities for Renewable Energy Based Mini-Grids in Rural India*, April 2017; Reuters "Investment rises in mini-grids as India races to meet energy goal," https://www.reuters.com/article/us-india-energy-renewables/investment-rises-in-mini-grids-as-india-races-to-meet-energy-goal-idUSKBN1F51FNhttps://www.reuters.com/article/us-india-energy-renewables/investment-rises-in-mini-grids-as-india-races-to-meet-energy-goal-idUSKBN1F51FN (Accessed Dec. 10, 2020).
[70] Smart Power India, "Mini-Grid Model," https://smartpowerindia.org/mini-grid-modelhttps://smartpowerindia.org/mini-grid-model (Accessed Oct. 27, 2020).
[71] Rockefeller Foundation, *Expanding Opportunities for Renewable Energy Based Mini-Grids in Rural India*, April 2017
[72] Rockefeller Foundation, *Expanding Opportunities for Renewable Energy Based Mini-Grids in Rural India*, April 2017
[73] Smart Power India, "Mini-Grid Model," https://smartpowerindia.org/mini-grid-modelhttps://smartpowerindia.org/mini-grid-model (Accessed Oct. 27, 2020).
[74] Smart Power India, "Mini-Grid Model," https://smartpowerindia.org/mini-grid-modelhttps://smartpowerindia.org/mini-grid-model (Accessed Oct. 27, 2020); Rockefeller Foundation, *Expanding Opportunities for Renewable Energy Based Mini-Grids in Rural India*, April 2017.
[75] Impact Alpha, "Tata Power and Rockefeller Foundation partner on 10,000 mini-grids initiative," (Accessed Nov. 5, 2020).
[76]Tata Power, "TP Renewable Microgrid marks its first anniversary by commissioning its 100th Solar Microgrid Project in Ratnapur, Uttar Pradesh," https://www.tatapower.com/media/PressReleaseDetails/1823/tp-renewable-microgrid-marks-its-first-anniversary-by-commissioning-its-100th-solar-microgrid-project-in-ratnapur-uttar-pradesh (Accessed Jan. 21, 2021);
[77] Tata Power, "TP Renewable Microgrid marks its first anniversary by commissioning its 100th Solar Microgrid Project in Ratnapur, Uttar Pradesh," https://www.tatapower.com/media/PressReleaseDetails/1823/tp-renewable-microgrid-marks-its-first-anniversary-by-commissioning-its-100th-solar-microgrid-project-in-ratnapur-uttar-pradesh (Accessed Jan. 21, 2021); Details regarding future interconnection agreements with TP Renewable Microgrid and DISCOMs has not been provided at this time.
[78] The Rockefeller Foundation, "Inside Tata Power and Rockefeller Foundation's Plan to Light Up 5 Million Households in India," https://www.rockefellerfoundation.org/blog/inside-tata-power-rockefeller-foundations-plan-light-5-million-households-india/https://www.rockefellerfoundation.org/blog/inside-tata-power-rockefeller-foundations-plan-light-5-million-households-india/ (Accessed Nov. 5, 2020).
[79] Impact Alpha, "Tata Power and Rockefeller Foundation partner on 10,000 mini-grids initiative," https://impactalpha.com/rockefeller-foundation-partner-on-10000-mini-grids-initiative/(Accessed Nov. 5, 2020).
[80] Husk Power Systems, "About us," https://huskpowersystems.com/about-us/ (Accessed Jan. 21, 2021).
[81] Alliance for Rural Electrification, *Private Sector Driven Business Models for Clean Energy Mini-Grids Lessons learned from South and South-East-Asia*, 2019.
[82] Alliance For Rural Electrification, "Mlinda Foundation 22.4 kWp Solar-Powered Mini-Grid in Shaitoli," 2019, https://www.ruralelec.org/project-case-studies/mlinda-foundation-224-kwp-solar-powered-mini-grid-sahitoli-indiahttps://www.ruralelec.org/project-case-studies/mlinda-foundation-224-kwp-solar-powered-mini-grid-sahitoli-india (Accessed Oct. 26, 2020).

[83] Bloomberg, Energy for All, *State of Global Mini-grids Market Report 2020*, https://minigrids.org/wp-content/uploads/2020/06/Indonesia_Case_Study.pdf (Accessed Nov. 5, 2020); PV Magazine, “Indonesia reveals national plan for micro and mini-grids,” https://www.pv-magazine.com/2018/10/11/indonesia-reveals-national-plan-for-micro-and-mini-grids/(Accessedhttps://www.pv-magazine.com/2018/10/11/indonesia-reveals-national-plan-for-micro-and-mini-grids/(Accessed Nov. 5, 2020).
[84] Akuo Energy, “Akuo Energy MCAI Project in Indonesia,” https://www.akuoenergy.com/en/mca(Accessedhttps://www.akuoenergy.com/en/mca (Accessed Nov. 5, 2020).
[85] Norton Rose Fulbright, “Renewable energy snapshot: Myanmar October 2019,” https://www.nortonrosefulbright.com/en/knowledge/publications/d63c2e71/renewable-energy-snapshot-myanmar (Accessed Jan. 5, 2021).
[86] Norfund, “Breakthrough Renewable Energy Project in Myanmar,” https://www.norfund.no/breakthrough-renewable-energy-project-in-myanmar/ (Accessed Jan. 5, 2021).
[87] Alliance for Rural Electrification, *Private Sector Driven Business Models for Clean Energy Mini-Grids Lessons learned from South and South-East-Asia*, 2019.
[88] Alliance for Rural Electrification, *Private Sector Driven Business Models for Clean Energy Mini-Grids Lessons learned from South and South-East-Asia*, 2019.
[89] Alliance for Rural Electrification, *Private Sector Driven Business Models for Clean Energy Mini-Grids Lessons learned from South and South-East-Asia*, 2019.
[90] Akuo Energy, “Akuo Energy MCAI Project in Indonesia,” https://www.akuoenergy.com/en/mca (Nov. 5, 2020).
[91] MNRE, "Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan: Solar off-grid component of Salient Features." , https://mnre.gov.in/solar/schemeshttps://mnre.gov.in/solar/schemes (Accessed Nov. 5, 2020).
[92] SCGJ, *Qualification Pack-Occupational Standards for Green Jobs: Solar-PV Project Helper*, https://sscgj.in/wp-content/uploads/2019/03/SGJ_Q0111_Solar-PV-project-helper_v1.pdf (Accessed Dec. 6, 2020); SCGJ, *Qualification Pack-Occupational Standards for Green Jobs*: *Solar-off-Grid Entrepreneur*, http://www.oraileducation.com/download _Solar-off-SGJ_Q0118 Grid-Entrepreneur-Model_Curriculum.pdf (Accessed Dec. 6, 2020)
[93] Rockefeller, *Integrating Mini-grids with India’s Evolving Electricity System*, 2017.
[94] Rockefeller Foundation, *Expanding Opportunities for Renewable Energy Based Mini-Grids in Rural India*, April 2017.
[95] Gaurav, P., Phone Interview, November 2020.
[96] Gaurav, P., Phone Interview, November 2020.
[97] Tata Power, “TP Renewable Microgrid marks its first anniversary by commissioning its 100th Solar Microgrid Project in Ratnapur, Uttar Pradesh,”https://www.tatapower.com/media/PressReleaseDetails/1823/tp-renewable-microgrid-marks-its-first-anniversary-by-commissioning-its-100th-solar-microgrid-project-in-ratnapur-uttar-pradesh (Accessed Nov. 5, 2020); The estimated 25kWp capacity value is reasonable given that Tata power has established 100 mini-grids with an average capacity of 30 kWp
[98] Tata Power, “TP Renewable Microgrid marks its first anniversary by commissioning its 100th Solar Microgrid Project in Ratnapur, Uttar Pradesh,”https://www.tatapower.com/media/PressReleaseDetails/1823/tp-renewable-microgrid-marks-its-first-anniversary-by-commissioning-its-100th-solar-microgrid-project-in-ratnapur-uttar-pradesh (Accessed Nov. 5, 2020).
[99] Alliance for Rural Electrification, *Private Sector Driven Business Models for Clean Energy Mini-Grids Lessons learned from South and South-East-Asia*, 2019.
[100] MNRE, "Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan: Solar off-grid component of Salient Features."
[101] Alliance for Rural Electrification, *Private Sector Driven Business Models for Clean Energy Mini-Grids Lessons learned from South and South-East-Asia*, 2019; The Rockefeller Foundation, “Inside Tata Power and Rockefeller Foundation’s Plan to Light Up 5 Million Households in India,” https://www.rockefellerfoundation.org/blog/inside-tata-power-rockefeller-foundations-plan-light-5-million-households-india/https://www.rockefellerfoundation.org/blog/inside-tata-power-rockefeller-foundations-plan-light-5-million-households-india/ (Accessed Nov. 5, 2020); Gaurav, P., Phone Interview, November 2020.

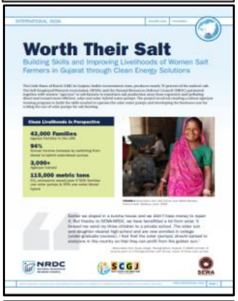
Highlighted Resources



Employment Potential of Emerging Renewable Energy Technologies Insights from the Floating Solar Sector



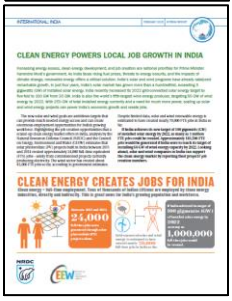
Powering Jobs Growth with Green Energy



Worth Their Salt: Building Skills and Improving Livelihoods of Woman Salt Farmers in Gujarat through Clean Energy Solutions

Powering Jobs Growth with Green Energy

Filling the Skill Gap in India's Clean Energy Market: Solar Energy Focus



Clean Energy Powers Local Job Growth in India

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