INCLUSIVE INNOVATIONS

Electrifying Rural and Remote Areas through Mini-Grids

Isolated grids connect millions of people at the bottom of the pyramid to power for the first time

HIGHLIGHTS

- Mini-grids provide decentralized, efficient electricity, connecting remote communities that lack access to the main grid.
- Mini-grids bridge the gap between small solar home systems and large grids, offering customers nearly the same service as a grid connection.
- Many systems can expand as demand for energy increases.
- Customer-friendly payment schemes, including mobile payment, prepaid scratch cards, and smart metering, make systems easy to use and provide back-end

Summary

Power supply is critical to development, but utilities in many low- and middle-income countries either lack the financial capacity to expand their grids to isolated rural areas or choose not to do so because of the low return on investment. Connecting households to mini-grids is a cost–effective solution in many areas.

Development Challenge

Some 1.2 billion people blacked access to electricity in 2013 (IEA n.d.). Most of them live in rural areas in Sub-Saharan Africa and South Asia. They rely on traditional biomass, kerosene, and batteries, which are expensive and pose environmental, safety, and health risks. Lack of regular access to power also hinders rural development, slows the formation of human capital, and reduces the quality of life for people at the bottom of the pyramid.

Power supply is critical to economic and human development, but utilities in many low- and middle-income countries either lack the financial capacity to expand their grids to isolated rural areas or choose not to do so because of the low return on investment. Off-grid solutions are therefore needed.

Business Model

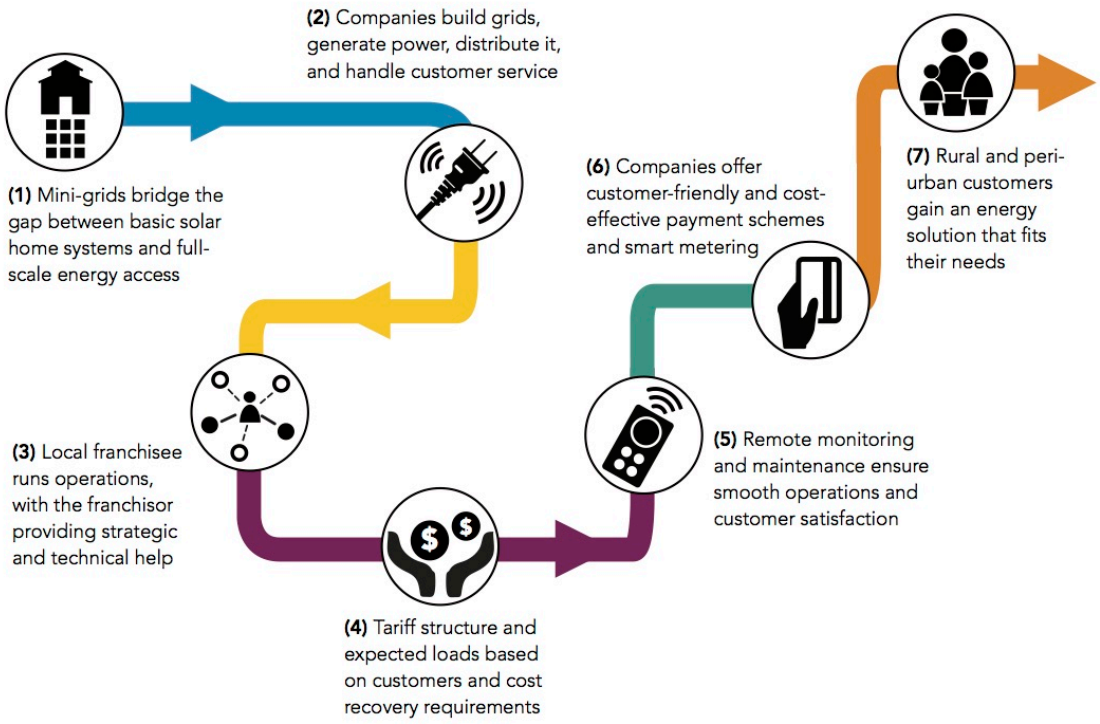
Components of the Model

A mini-grid is a set of electricity generators and storage devices connected to a distribution network that provides electricity to communities and customers that are not connected to the main grid. Most of them use low alternating current (AC) voltage (220V–380V) or direct current (DC) with a centralized production and storage system and have installed capacity of 5kW–500kW (World Bank 2008). Companies operating mini-grids usually build the grids, generate and distribute the power, and take care of all customer-related services, including marketing and bill payment (figure 1).

WORLD BANK GROUP

This series on Inclusive Innovations explores business models that improve the lives of those living in extreme poverty. Editors are Elaine Tinsley and Cristina Navarette Moreno. Researched and developed by Endeva and Ashley Insight.

Figure 1. Components of the mini-grid model



Mini-grids use a range of technologies. Diesel-powered mini-grids are expensive and unreliable. For this reason, many mini-grids combine diesel with hydro or other renewable energy resources, which reduces storage costs. Many mini-grids could be reconfigured with renewable sources of energy.
Mini-grids bridge the gap between basic and full-scale energy access, enabling people to use electricity to light homes and power devices such as cookstoves, refrigerators, and mobile phones. An estimated 29 million rural or peri-urban households worldwide could be served on a commercial basis by isolated mini-grids (Tenenbaum and others 2014).

Cost Factors

The size of the required investment and payback period vary, depending on size, technology used, and other factors such as distribution line. Village grids that can be connected to the national grid at a later stage cost more than low-voltage DC micro-grids that cannot be connected to the national grid.

In Tanzania, Devergy covers the installation cost of the micro-grid, except for a small fee charged to users at the time of first connection. The initial investment of USD 6–12 per household covers metering, wiring, two LED bulbs, and installation. The balance is built into the per-use energy charges users pay. This arrangement makes Devergy's proposition more affordable than solar home systems, which require larger upfront capital outlays. The payback period of a Devergy system is about two and a half years.

Table 1. Monthly end-user costs for electricity provided by selected mini-grid providers

Company/country	Volume of energy provided	Monthly cost
DESI Power (India)	11W	USD 1.50
Devergy (Tanzania)	Enough power to charge 2 LED lights and a mobile phone	About USD 5.00
Husk Power Systems (India)	Enough power to charge 2 x 15W CFL lights and a mobile phone	USD 2.20

Revenue Streams

Mini-grids generate revenues by selling electricity to consumers and other customers. In India DESI power sells electricity to anchor clients, such as telecom towers and rice mills. Revenues from these customers cross-subsidizes service for household use.

Financial Viability

Costs and tariff structures of mini-grids vary, depending on the size and energy source of the mini-grid, the socioeconomic status of users, the type of operator (private or public), the ownership model, and the funding structure (for-profit, partly or fully subsidized). Mini-grids may be owned and managed by the state, private sector or communities. Often a combination of different actors is involved, owning or managing different parts of the system, such as the production, distribution and demand management systems. (GVEP 2011)

Many mini-grids are set up as part of the national electrification initiative and are at least partly financed by governments. Other companies are strictly private. One, Husk Power Systems, is profitable at the plant level, with a gross margin of 20 percent.

It typically takes two to three months for a plant to reach operational profitability and two and a half to three years to recoup capital expenditures (with subsidies). Husk Power Systems has secured formal equity investment, but grants and some equity from the owners still finance capital and operating costs. The company is struggling to secure capital needed to develop its franchise approach, because banks are not willing to take the risk on an early-stage venture.

Partnerships

Enterprises operate based on four main models:

- The **utility-based model** is the most common approach to rural electrification in developing countries. The utilities may be national public institutions, private units, or cooperatives. They focus mainly on areas consigned by governments. Powerhive East Africa Ltd., an impact-driven, for-profit mini-grid developer, is the first private company in Kenya to receive a utility concession to generate, distribute, and sell electricity to the Kenyan public (Powerhive 2015).
- **Private sector models** are either fully for-profit or partially subsidized. Commercial entities develop the mini-grids and either operate, lease, or sell them to other actors. For-profit village grids charge tariffs that allow them to earn profits, achieved through the ABC model (Anchor client, Business, Consumer). Under this approach, the operator sells electricity through a power purchase agreement to an anchor customer, such as a mobile phone company. Small businesses and individuals with lower energy consumption are serviced at an affordable price thanks to the economies of scale achieved through the anchor client.
- **Community-driven models** tend to be partially or fully subsidized. Government organizations such as the Orissa Renewable Energy Development Agency (OREDA) in India fund the implementation and operation of small village mini-grids. The community—often represented by a village electrification committee—manages operations, tariff collection, and maintenance. Community models can offer subsidized tariffs for basic energy services for a few hours a day to low-income customers.
- **Hybrid business models** combine aspects of various approaches in order to maximize effectiveness and efficiency.

Implementation: Delivering Value to the Poor

Awareness

All stakeholders—customers at the base of the pyramid, local businesses, government (from local governing structures to national governments), and the banking sector—need access to information

about all available energy solutions to find out which solution is affordable and best fits their needs. Tanzania's Scaling-Up Renewable Energy Programing Low Income Countries (SREP) program mapped out which households could be connected to the grids, how many would best be connected through mini-grids, and how many could be connected by stand-alone solutions such as solar home systems. It created awareness about the different solutions and provided the political framework supporting the development of mini-grids (Climate Investment Fund and SREP 2013). To create awareness at the customer level, Mera Gao Power staff visits villages for and collaborates with NGOs.

Acceptance

Strategic planning, not just a site analysis and the identification of technical solutions, is a key aspect of running a successful mini-grid business (Inversin 2000). In-depth studies of the national electrification agenda, the economic circumstances of potential customers, and projections of future development in the community (for example, the potential productive use of energy and plans for extending the central grid) are essential.

Successful developers integrate local partners in the development of new sites; local knowledge is as vital as technical knowledge. The German enterprise Inensus funded the joint venture ENERSA S.A. with the Senegalese company Matforce CSI to set up mini-grids in Senegal in order to be able to tap local knowledge.

Monitoring and maintenance are critical to ensure the smooth operation of the grid. Remote monitoring in combination with a local service team helps improve the efficiency of operations and thus increase customer satisfaction and profitability.

Availability

Mini-grid operations are locally based; much of the day-to-day business cannot be performed at a headquarters located elsewhere. Many companies (including Husk Power Systems, India) therefore use a franchise model to facilitate scaling, transferring responsibility for local operations and investments to the franchisee (the franchisor provides general strategic, technical, and practical expertise).

Affordability

Tariff structures and expected loads are developed to match the customer base and cost-recovery requirements. India's D.E.S.I Power projects future customer use of power to size the grid correctly in order to strike the right balance between affordability and future growth of the grid. Tariff collection that meets the reality of customers' situations is critical. Powerhive, in Kenya, offers customers the opportunity to prepurchase electricity through mobile banking services.

Results and Cost-Effectiveness

Scale and Reach

The number of customers ranges from a few to a few hundred per mini-grid. Devergy started operations in Tanzania in 2012; it now serves almost 1,000 customers. Husk Power Systems, founded in 2007 in Bihar, India, serves 210,000 people in 250 villages, through 91 plants powered by rice husk. OREDA serves customers in India who earn USD 16–24 a month. They can afford its services only because they are subsidized. In Tanzania Devergy has connected about 1,000 households in six villages. It is connecting more than 100 new households every month.

Desi Power provide services to 14 villages in India, reaching 2,000 people. Its biomass gasifiers provide electricity that is more reliable and about 25 percent less expensive than diesel-based generation. In

all villages where DESI Power has installed a plant or set up a solar pump for irrigation, it has replaced the diesel generator sets, reducing carbon dioxide emissions.

Improving Outcomes

Mini-grids have a variety of positive effects. They extend villagers' activities beyond daylight hours, enhancing the quality of life and promoting economic development, by allowing local shops, eateries, and small-scale manufacturing units to stay open longer. They increase the time children can study, improving educational outcomes. They reduce indoor air pollution and the risk of fires from kerosene, improving health and reducing accidents. They save consumers money. They prevent damage to the environment from the improper disposal of zinc-carbon batteries (widely used for operating radios). They also create jobs. DESI Power, for example, has created at least 25 direct and 200 indirect jobs per village.

Cost-Effectiveness

Mini-grids can be a viable and cost-effective route to electrification. Rural residents in Tanzania who use a mini-grid, for example, spend about 20 percent less on lighting and about 50 percent less on phone charging than rural residents without access to the mini-grid.

Many demonstration projects have proved the technical feasibility of this solution. The business case for mini-grids has yet to be made fully, however, because of the complexity of regulatory frameworks, financing challenges, and other factors.

Scaling Up

Challenges

The pace at which mini-grids are being constructed remains limited, because of a variety of challenges. Most can be transformed into drivers.

Role of Government and Public Policy

Governments can promote the expansion of mini-grids in many ways. They can develop a long-term vision for the sector (IFC 2012) and share information on their plans to extend the main grid. They can streamline licensing and approvals, set appropriate tariffs, help increase access to financing, create a market ecosystem, training on mini-grids operations, and facilitate information flows.

Streamlining licensing and approval: The public sector can reduce costs and encourage entry by simplifying licensing and approval schemes. Sri Lanka's renewable energy policy is a good example of how regulation can promote electrification. The country set up an enabling regulation for renewable energy systems below 10MW (to feed into the grid) in 1996. Regulations were revised several times; by the end of 2011, 243MW of capacity had been installed, all of it operated by private companies (Tenenbaum and others 2014).

The government of Tanzania facilitates the set-up of mini-grids for up to 1MW by allowing these small systems to forgo complex licensing process; systems below 100kW do not even need approval of end-consumer tariffs (Tenebaum and others 2014). This enabling political environment induced Devergy to start operations in Tanzania. In contrast, onerous licensing rules and high tariffs in Ghana forced Devergy's license partner there had to stop its operations after installing 300 connections.

Setting appropriate tariffs: Electricity generation costs are higher for mini-grids than for grid connections. Policy makers have to decide whether to structure tariffs to reflect costs or set uniform national tariffs, which would imply cross-subsidization of mini-grid customers. Tariffs that reflect costs may be the fastest way to provide electricity.

Increasing access to financing: Mini-grids require upfront investment of up to a few million dollars. The public sector and donors can increase access to financing by enterprises, leveraging public-private partnerships, providing smart subsidies for grid extension, and guaranteeing loans from commercial banks (IFC 2012). Debt financing mechanisms and guarantees, such as the German government's export credit insurance, can support the scaling of mini-grids.

Results-based financing involves the cash payment or nonmonetary transfers by a national or subnational government after predefined results have been attained and verified. Devergy has developed a program in which contractors are paid in full only when the quality of the installation has been proven in operations. Combining results-based payment with results-based finance could leverage the scaling progress.

Create a market ecosystem: Mini-grid companies need to establish linkages with local and national businesses, communities, sectors with demand for power, international developers, technology providers, and financiers. Fostering such a market ecosystem offers a high-impact opportunity for the public sector and donors. Support can be provided by enabling the development of a more standardized technology.

Provide training: Public technical institutes or vocational schools could offer training to equip staff with the technical qualifications for installation and maintenance of mini-grids as, for example, the Ethiopian Adama Institute for Sustainable Energy at the Adama Science and Technology University does.

Facilitate access to information: Public sector actors and donors can help ensure access to relevant information for all stakeholders (public sector, communities, developers, investors, third sector organizations). This includes public disclosure of government plans and time frames for central grid extensions, as this informs enterprises of areas of market potential. Facilitating information access includes raising awareness among end-consumers that energy is a purchased (not free) product in order to discourage theft.

Table 2. Enterprises providing mini-grid access

Company/Economy	Country	Description
Aga Khan Rural Support Programme	Pakistan	Pioneer in community-based development approaches builds locally managed mini-hydro plants throughout Chitral district. Community-owned and -operated plants generate clean, affordable, and reliable electricity 24 hours a day.
Community, Energy and Technology in the Middle East	Israel, West Bank and Gaza	Israeli-Palestinian organization provides green energy and clean water services to off-grid communities using environmentally and socially sustainable methods, empowering some of the poorest and most marginalized communities in the West Bank and Gaza through the construction of wind and solar energy systems, clean potable water solutions, capacity building, and reliable maintenance.
Desi Power	India	Biomass gasification plants (30kW–150kW) help set up microenterprises /cooperatives by ensuring biomass supply and plant load; targets Industrial customers with high peak loads requiring reliable power.

Devergy	Tanzania	Provides low-power solar micro-grids that are typically shared by groups of up to five households. Modular nature of panels allows installed capacity to be easily expanded when demand increases.
Electricité de Haiti (EDH)	Haiti	Diesel-run, municipal-owned mini-grids. Formalized process to develop these micro-grids evolved over years, and currently involves several levels of public agencies and private sector (for profit and NGOs) players working together to build, operate and maintain a micro-grid to electrify rural communities.
Foundation Rural Energy Services	Burkina Faso, Guinea-Bissau Mali, South Africa, Uganda	Small multinational uses market-based approach to establish small-scale commercial electricity companies in areas that have no grid access.
Green Empowerment/ Tonibung/PACOS	Malaysia	Green Empowerment and Tonibung are nonprofits working together to finance and develop micro-hydro-micro-grids while integrating community empowerment goals into rural electrification. The NGO PACOS is the community empowerment partner.
Husk Power Systems	India	Builds small-scale systems in remote rural villages that generate and distribute power cheaply enough for base of the pyramid consumers to afford. Each system consists of a 30kW–50 kW power plant that runs entirely on rice husks. Micro-grid connects subscribers directly to the plant using insulated wires strung from bamboo poles.
IBEKA	Indonesia	Works with communities to develop their local skills and builds their ownership to manage and maintain off-grid hydro schemes. Lobbied to change law so that national supplier must buy electricity from small grid-connected hydro-schemes, a change that has enabled new schemes to be built under community management and existing off-grid schemes to be connected later if grid expands.
Inensus GmbH (Sengalese JV: INENSUS West Africa S.A.R.L.)	Senegal, Somalia, Tanzania	Integrates small wind turbines with solar and diesel power sources. The hybrid design optimizes power set-ups, with wind and solar resources complementing each other, reducing diesel fuel consumption and battery cycling.
Mera Gao Power (MGP)	India	Provides service-specific micro-grids to meet lighting and mobile charging requirements of rural people.
Powerhive	Kenya	Off-grid metering and control solutions offer customers opportunity to prepurchase electricity for commercial and residential use through mobile banking services. Acts as intermediary between generators and users.
Remote Village Electrification Program (CREDA)	India	Government agency installs and operates mainly solar pholtovotaic micro-grids through contractors.
Saran Renewable Energy	India	Provides reliable electricity to small businesses from biomass gasifier and reliable income to farmers who produce the biomass.

WBREDA	India	Electrifies isolated communities, including villages in the Sundarbans, a mangrove-filled delta in the Bay of Bengal and a Bengal tiger reserve.

References

Climate Investment Fund, and SREP (Scaling-Up Renewable Energy Programing Low Income Countries). 2013. *Investment Plan for Tanzania.* Ministry of Energy and Minerals, Dar es Salaam.

IEA (International Energy Agency). n.d. Energy Access Database. http://www.worldenergyoutlook.org/resources/energydevelopment/energyaccessdatabase/.

IFC (International Finance Corporation). 2012. *From Gap to Opportunity: Business Models for Scaling Up Energy Access.* Washington, DC. http://www.ifc.org/wps/wcm/connect/ca9c22004b5d0f098d82cfbbd578891b/energyaccessreport.pdf?MOD=AJPERES.

Inversin, Allen R. 2000. *Mini-Grid Design Manual.* Washington, DC: World Bank. https://www.esmap.org/node/1009.

GVEP International (Policy Briefing). September 2011. The history of mini-grid development in developing countries http://www.reeep.org/sites/default/files/Mini percent20Grid percent20Development percent20in percent20Africa.pdf

Powerhive. 2015. *Powerhive Subsidiary Becomes First Private Utility in Kenya's History to Be Licensed to Sell Electricity to the Public.* Nairobi. www.powerhive.com/powerhive-subsidiary-becomes-first-private-utility-in-kenyas-history-to-be-licensed-to-sell-electricity-to-the-public.

Reegle. 2015. *Scaling up Renewable Energy Programme (SREP) Tanzania*. http://www.reegle.info/policy-and-regulatory-overviews/TZ. https://www-cif.climateinvestmentfunds.org/sites/default/files/meeting-documents/srep_tanzania_investment_plan_design.pdf

Schnitzer, Daniel Deepa Shinde Lounsbury, Juan Pablo Carvallo, Ranjit Deshmukh, Jay Apt, and Daniel M. Kammen. 2014. *Microgrids for Rural Electrification: A Critical Review of Best Practices Based on Seven Case Studies.* Washington, DC: United Nations Foundation. http://energyaccess.org/images/content/files/MicrogridsReportFINAL_low.pdf.

SE4ALL. 2014. *High Impact Opportunity Clean Energy Mini-Grids.* Vienna: United Nations. http://www.se4all.org/hio/clean-energy-mini-grids.

Sevea. 2013. *Case Study: Husk Power Systems. Power to Empower.* Les Marches, France. http://www.riaed.net/IMG/pdf/Case_study_HPS.pdf.

Tenenbaum, Bernard, Chris Greacen, Tilak Siyambalapitiya, and James Knuckles. 2014. *From the Bottom Up: How Small Power Producers and Mini-Grids Can Deliver Electrification and Renewable Energy in Africa.* Washington DC: World Bank.

World Bank. 2008. *REToolkit: A Resource for Renewable Energy Development.* Washington, DC. http://siteresources.worldbank.org/INTRENENERGYTK/Resources/RETOolkit_issues_note.pdf.

Additional Reading

Duflo, Esther, Michael Greenstone, and Rema Hanna. 2008. "Indoor Air Pollution, Health, and Economic Well Being" Department of Economics, MIT, Cambridge, MA. http://economics.mit.edu/files/2375.

GIZ (Deutsche Gesellschaft für Internationale Zusammenarbeit). 2014. *RECP: Mini-Grid Toolkit. Policy and Business Frameworks for Successful Mini-Grid Roll-Out.* Eschborn, Germany. http://euei-pdf.org/sites/default/files/files/field_pblctn_file/RECP_MiniGrid_Policy_Toolkit_1pageview percent20(pdf, percent2017.6MB, percent20EN_0_0.pdf.

Profile: Devergy

Using pay-as-you-go solar micro-grids in Tanzania to provide rural consumers with affordable energy

Challenge

Tanzania has one lowest electrification rates in the world. Just 14 percent of its people—a mere 3 percent in rural areas—has access to electricity (World Bank n.d.)

This solar panel mounted on a tripod provides affordable energy to households in a Tanzanian village.

The main sources of energy in rural areas include traditional biomass, kerosene, and batteries, which are not only expensive but also pose environmental, safety, and health risks. Lack of access to regular supply of power also hinders rural development. Utilities either lack the financial capacity to expand their grids to isolated rural areas or choose not to so because of the low potential return on investment.

Innovation

Founded in 2010, Devergy (http://www.devergy.com/) provides energy services through low-power solar micro-grids that are typically shared by up to five households. The modular nature of the product allows the company to optimize the size of the system to meet the exact demand of users, which, at least initially, typically use it only to charge their mobile devices or provide lighting, avoiding the "oversizing" often associated with traditional mini-grids.

Devergy covers the installation cost of the micro-grid, except for a small fee charged at the time of first connection. The initial investment ranges from USD 6 to USD 12, which covers metering, wiring, two LED bulbs, and installation. The balance is built into the per-use energy charges paid by users. This arrangement makes Devergy's proposition for the end-user more favorable than solar home systems, which require higher upfront capital outlays. The payback period of a Devergy system is about two and a half years.

Devergy uses differential pricing based on users' purchasing power. It charges better-off customers a higher price in order to cross-subsidize the tariffs of lower-income customers. Prepaid energy packages start at USD 0.20 a day.

The systems generate energy in direct current (DC), saving 20 percent of the system costs by eliminating the need for a costly inverter. As most electrical appliances available in the markets are made to run on alternating current (AC), Devergy also supplies energy-efficient DC products (lighting products, refrigerators, TVs).

A key feature of the system is the household energy meter. Users can top up the energy account by buying Devergy vouchers from local stores, from Devergy engineers in the village, or through mobile money. Selling energy based on hours of light, phone charging, or other applications makes it easier for customers to choose the services they want and monitor their consumption.

Devergy uses a community-based communication approach, which makes users a part of the decision-making process from the start of a project. Meetings with villagers, elders, and leaders are held to discuss and assess users' needs.

Impact

Devergy has connected about 1,000 households in six villages to its solar grids, providing them with access to cleaner, safer, and less expensive energy. More than new 100 households in Tanzania are being connected every month.

Rural residents in Tanzania typically spend USD 6–25 a month on kerosene, phone charging, and zinc-carbon batteries for radios. After installation of Devergy's micro-grids, they spend as much as 20 percent less than they had been spending on kerosene for lighting and about 50 percent less for phone charging.

One of the key impacts of access to energy is stimulation of economic activities by allowing local stores, restaurants, and small-scale manufacturing units to operate for longer hours. Micro-grid energy also overcomes the risk of fire and accidents caused by kerosene use, and the lighting it provides allows children to study at night. Lack of a proper disposal system for zinc-carbon batteries (widely used for operating radios) has severe environmental and health risks, including pollution of the soil with toxic materials. Devergy micro-grids help address all of these issues.

Most of the company's employees are local people, who provide the technical support for the installed systems and act as a continuous interface between Devergy and the communities it serves. By providing individuals in the community with solar engineering training, Devergy aims to improve their income prospects.

Scaling Up

Devergy has mainly targeted household customers. Going forward, it plans to develop solutions to cater to the needs of businesses as well. Some of the solutions under development include refrigeration, entertainment applications (such as cinemas), and agricultural equipment (grain mills and rice huskers).

The regulatory framework in Tanzania provides a conducive ecosystem for private sector participation. A project below 100 KW, for example, does not require a government license or approval for tariffs. The government's "Rural Energy for Rural Electrification" program promotes private and NGO participation to set up renewable energy mini- and micro-grids that sell power directly to retail customers. The government has also removed value added tax and duties on solar components, such as panels, batteries, inverters, and regulators, allowing end-users to buy solar at an affordable price.

The regulatory framework in other countries may not be as supportive as in Tanzania, which could constrain the growth and replication of Devergy's model. The partnership in Ghana, for example, did not move beyond the pilot stage because of regulatory issues regarding licensing and tariffs.

A few factors constrain expansion. The working capital requirements of Devergy are high, because it finances its sales. (Other sources of financing for customers, such as microfinance, tend to go toward income-generating activities, not the purchase of household applications.) Devergy's operations are not yet profitable. It has relied largely on grants and investments by the DOEN Foundation, Persistent Energy Partners, EEP Africa, and others. Additional grants and capital are required to sustain the growth momentum and expand the user base.

Reference

World Bank. n.d. Tanzania Energy Development and Access Project (TEDAP) and SPPs. Washington, D.: World Bank https://www.esmap.org/sites/esmap.org/files/TEDAP_percent20SPPs_percent2011-18.pdf.

Profile: DESI Power

Providing green power in India through minigrids

Challenge

Despite its fertile land, the district of Araria in the Indian state of Bihar is one of the poorest in India. To escape its poverty, many young villagers migrate to cities in search of jobs. The challenge is to reduce migration by improving agro-productivity by selling irrigation water to small-scale farmers and creating nonagricultural jobs in the district.

DESI Power empowers rural communities with electricity and irrigation solutions.

Innovation

Founded in 1996, DESI Power (www.desipower.com) provides reliable and renewable electricity and employment to reduce rural poverty and promote economic development by installing and running biomass mini-grids. The mini-grids provide households with light, farmers with irrigation water and agriculture processing, and small entrepreneurs with increased earning opportunities.

From 1998 to 2008, DESI Power built, tested, and modified power plants and mini-grids until it created a technology that worked in the rural context: stand-alone power plants that run on local biomass and solar power. The company now operates mini-grids in 14 villages. To make the business model financially viable, it sells electricity to anchor clients like telecom towers, rice mills, and other clients that use electricity for productive use. It uses the revenues from these customers to cross-subsidize service for household use.

The radius of the larger power stations is one kilometer. People who live outside that power station's catchment area can be connected through DESI Power's tiny grids, which supply 10–20 households with enough power to light their homes, charge their phones, and supply irrigation water.

DESI Power trains villagers to run and maintain the village grid, often employing women. It seeks to create self-reliant villages with a decentralized electricity-driven development process based on local value addition of agro-residues, renewable energy, and other resources. About two-thirds of new income generated stays in the village.

Impact

In the 14 villages in which DESI Power is active, 2,000 people benefit directly from its power. The company's biomass gasifiers provide electricity that is about 25 percent less expensive than diesel-based generation and more reliable. In all villages where DESI Power has installed a plant or set up a solar pump for irrigation, it has replaced the diesel generator sets, reducing CO_2 emissions. In addition, the company has created at least 25 direct and 200 indirect jobs per village.

Scaling Up

DESI Power has scaled up only slowly, partly because of lack of finance. One power plant and micro-grid requires USD 55,000–70,000 of investment. Electricity-consuming microenterprises can create local jobs, but it costs about USD 15,000–25,000 per village to set up businesses and upgrade

machines. DESI Power is now in the process of raising funds to build power plants, micro-grids, and some anchor loads in 100 villages, an effort that requires substantial funds.

The operations of DESI Power are not yet profitable, because of the large capital outlays, lack of constant load, and fact that no financial arrangements are available to help local entrepreneurs develop their businesses in rural areas. The first pilot power plant in a village was financed by the grant DESI Power won from the World Bank's Development Marketplace. Other donors, such as the Rockefeller Foundation, are providing soft loans and grants to invest in new power plants, micro-grids, and some key anchor loads.

The government's focus on central grid expansion and its lack of support for decentralized power provision, limit scaling up. Without the government's cooperation, DESI Power cannot create a micro-grid using central grid infrastructure, which would enable it to speed up project development and access to many customers. There is no policy that accepts and promotes mini-grids as a means of reaching full electrification in rural areas. A solution for the coexistence and interaction of the centralized and decentralized systems, would greatly improve access to energy in rural areas.