Mini-Grid Policy Toolkit

Country: INDIA

Project: Husk Power Systems

Private Operator Model

Project Summary

A large percentage of India's population (over 70%) lives in rural areas and lacks access to basic electricity services. The Government of India has implemented several programmes over the years in order to address this gap, but despite these efforts, over 33% of the population still lacks access to electricity. With support from one such programme within the Ministry of New and Renewable Energy, Husk Power Systems Private Limited (HPS), a private company established in 2008, has implemented an innovative biomass gasifier-based solution to deliver electricity to around 200,000 people across 300 villages through 84 mini-grids using locally available biomass residues. Initially, HPS adopted a "Build Own Operate Maintain" (BOOM) model to prove the business case and viability of such an approach, but transitioned over time to models with decreasing ownership structures in order to enable rapid scale-up. While HPS proved the business case for such a solution and also developed technology that is rugged and easy to operate in a rural setting, issues regarding the availability of feedstock, skilled man-power, maintenance, and access to finance (in the case of its more recent models) have presented challenges for rapid scale-up. With the recent shift in policy focus within India to solar, HPS has also implemented solar micro-grids and an innovative biomass-solar PV hybrid solution.

Background

India has one of the largest un-electrified populations in the world, with over 33% of its population, or an estimated 400 million people, without access to electricity. While grid connectivity in rural areas across most Indian states is poor at around 55%, it is even worse in a few states in North and East India, where it is only 10-20%. Even where consumers are connected to the grid, the availability, reliability, and quality of electricity is extremely low. Most rural communities are therefore dependent on kerosene and diesel for their basic lighting needs, which are expensive and polluting. This is especially true in the state of Bihar (where HPS operates), where it is estimated that the available generation capacity can cater to only around 6% of the households (89% of its population of 82.9 million lives in rural areas), and the annual per capita consumption stands at 117.48 kWh versus the national average of 778.63 kWh.

Recognizing that lack of access to electricity is a significant barrier to economic development in rural areas, the Indian government has enacted several policies and schemes to increase access to electricity in rural areas, both through grid extension and support to the expansion of renewable energy use in these areas.

It was in this context that HPS initiated its operations in 2007 (formally established in 2008) to deliver low cost electricity services through biomass gasification for lighting and mobile phone charging using locally available agro-residues, which were hitherto considered as waste. Rural households received a safer, better, and cleaner source of lighting at an affordable cost (slightly lower than what they were spending on kerosene at the time). Furthermore, the plant also generated income within the local community for the feedstock required for the plant operations as well as employment opportunities within the plant (including the making of incense from the residual biomass char).

Basic Information

Location	Bihar, India
Project implementer	Husk Power Systems Private Limited
Project date	August 2007 (formally established in 2008) – Present
Beneficiaries	80+ mini-grids to date; 400 – 500 customers / mini-grid (includes households, local shops, businesses, etc.); approximately 3000 beneficiaries / mini-grid
Project cost	< USD1,300/kW; ~ USD 41,000 for a 32 kW gasifier grid (including all equipment and wiring)

Policy & Regulatory Framework

Electricity is a concurrent subject in India, with the Central Government as well as the individual state governments having the power to enact laws in this regard. While the Central Government focuses on the overall objectives for the country and inter-state matters, the individual states focus on state specific priorities.

The overarching legislation governing the electricity sector in India is the Electricity Act 2003, which nullifies all earlier enactments, and aims to introduce greater competition in the electricity sector. Within the framework of this Act, the Government of India has enacted the National Electricity Policy (2005), the National Tariff Policy (2006), and the Rural Electrification Policy (2006). Among other things, there is significant emphasis placed on the promotion of renewable energy sources (by the State Electricity Regulatory Commissions) within the Act and resultant policies.

Under the Rural Electrification Policy, the emphasis was primarily on grid extension, with off-grid options considered only where grid extension was not feasible. While earlier targets for grid extension have been missed, the Prime Minister recently made an ambitious announcement that the grid will be extended to all parts of India that currently do not have access, within one thousand days. Further, under another recent initiative, 24 x 7 Power for All, efforts are being made to achieve

feeder separation, especially in rural areas, whereby 24 x 7 single phase power supply will be made available to all rural households.

The grid extension and feeder separation is being implemented by the Rural Electrification Corporation (REC) under the Deen Dayal Upadhyaya Gram Jyoti Yojana (DDUGJY) of the Ministry of Power, which subsumes the efforts under the earlier Rajiv Gandhi Grameen Vidyutikaran Yojana, 2005 (RGGVY). Under this scheme, extension of the grid and strengthening of the rural distribution infrastructure are supported by a 60% grant (85% in the case of special category states) from the Central Government, a 30% loan (10% in the case of special category states; 50% of the loan to be converted to grant on achieving prescribed milestones), and the balance is covered by the distribution companies' own contribution. The scheme also provides connections at no cost to households living below the poverty level. In remote areas or areas where the grid exists but the supply of electricity is less than 6 hours, the scheme allows for the setting up of Decentralized Distributed Generation Systems, where 100% of the capital cost (including O&M costs for a period of five years) is covered by the Government. The payments are structured in a way (30% spread over a five year period) that ensures sustained operations by the private developer.

India is one of the few countries with an independent ministry for the promotion of renewable energy sources, the Ministry of New and Renewable Energy (MNRE). As India has significant potential to generate electricity from various renewable energy sources such as wind, solar, biomass, hydro, geothermal, etc., several schemes have been implemented for the promotion of renewable energy in both the grid connected and off-grid space. In the grid connected space, several states have implemented preferential tariffs for electricity generated from renewable sources and have established a Renewable Purchase Obligation target that requires the states to source a certain percentage of their total electricity from renewable sources. In addition, a Renewable Energy Certificate (REC) market has been established, regulated by the Central Electricity Regulatory Commission (CERC), to balance out regional disparities in renewable energy sources.

While the initial focus in the 1990s was on wind energy, the focus in recent times, following the launch of the Jawaharlal Nehru National Solar Mission in 2010, has been on solar energy. The original target under the National Solar Mission for the grid connected component was 20 GW by 2022, but this has recently been revised upward to 100 GW. The prices of solar PV have also declined rapidly with the recent market activity (lowest bid of ₹ 5.05/kWh (~ USD0.075/kWh) in recent auctions for 300MW capacity in Madhya Pradesh) with grid parity expected by 2017. The target for the off-grid component remains the same at 2 GW, but progress has been slow on this front.

In addition to solar, the MNRE implemented schemes for the promotion of biomass, small hydro, co-generation, etc., but the progress has been slow in recent times due to the increased attention on solar. The current scheme for the promotion of biomass gasification projects, under which HPS projects were set up, provides for ₹ 15,000/kW (~ USD222/kW).

While there are several schemes promoting mini-grids for off-grid electrification, including private

sector efforts such as HPS, there is no clear strategy at present for incorporating off-grid mini-grids onto the national grid if it reaches these locations, although there is a possible approach outlined by the Forum of Regulators.

Today, along with the traditional Central Government and state-level actors, there is also an increasingly active private sector in most of parts of the electricity value chain, especially in generation, transmission, and power trading. In the case of supply in rural areas through off-grid projects, there is no licensing requirement or regulatory oversight as per the Act.

Technology

The typical HPS solution has a capacity of 25-50 kW and is composed of a gasifier, filters, a gas engine connected to an electricity generator, and a distribution grid. The gasifier is a modified version of a dual fuel system that has been designed to operate in a single fuel mode with reduced tar content. While the predominant fuel is rice husk, which is abundantly available in the region, it can also operate on other agricultural residues such as mustard stems, corn cobs, etc.

The gasifier is a down-draft type, where the fuel is loaded from the top into the hopper. Partial combustion of the fuel occurs within the combustion chamber under restricted supply of oxygen to give producer gas, which comprises hydrogen, carbon monoxide, and methane. The resultant gas is cooled and cleaned through a series of filters and is subsequently burnt in an engine connected to a generator, which generates electricity at 240V, single phase. The residual char is collected at the bottom of the chamber and subsequently removed.

Electricity is distributed at 240V through a low cost single phase distribution grid comprising insulated cables mounted on bamboo poles. Electricity is distributed to consumers within a radius of 2 km in order to keep the voltage drop and losses to acceptable levels. Consumption is controlled through low cost pre-paid meters (< USD8) developed in-house, which leads to reduced theft. Remote monitoring features have also been introduced for better monitoring and tracking of performance of the plants.

Operator Model

Business Model

When delivering electricity to rural consumers, HPS adopts one of the following models, which vary as a function of the ownership structure:

- Build Own Operate and Maintain (BOOM) – this was the model adopted in the initial years, when HPS set out to prove the business case of such an approach. Under this model, HPS operated as an off-grid utility that was responsible for all aspects of the operations.
- Build Own and Maintain (BOM) – Once the business case was proven, HPS moved to a model where it partnered with a local entrepreneur, who made a small contribution to the capital costs (up to 10%), and was responsible for the operations of the plant. HPS provided

maintenance services for a monthly fee, with the entrepreneur retaining the balance monthly earnings. This model allowed for lesser involvement of HPS in the day to day operations of the plant, while still maintaining the ownership and associated risks. With regards to the entrepreneur contribution, HPS also supported the entrepreneur in obtaining a bank loan for said contribution, although this posed significant challenges.

- Build Maintain (BM) – This was an approach adopted in markets beyond Bihar (especially in Africa), where HPS functioned purely as an equipment supplier providing installation and post-installation maintenance services, with the local entrepreneur owning and operating the plant.

While a large part of HPS's current portfolio (over 60 plants) consists of plants established under the BOOM model, HPS believes future expansion and scale will be achieved through the BM model. HPS also established a university to develop manpower, including both technicians and entrepreneurs, for its plants and training is a part of the offering under the BOM and BM models.

Financing

HPS received initial grant support from its strategic partner, Shell Foundation, of approximately USD 2M, which not only contributed to the early R&D costs, but also helped attract additional financing. HPS also raised "pre Series A" funding (equity investment) of USD 1.65M in 2009 from Acumen Fund, Bamboo Finance, LGT Venture Philanthropy, Draper Fisher Jurvetson, CISCO, and the International Finance Corporation. HPS subsequently managed to raise a loan of USD750,000 from the Overseas Private Investment Corporation (OPIC) and a further "Series A" equity investment of USD 5M in 2012 towards its expansion plans. HPS also receives a government subsidy of approximately USD 7,100 for each plant from the Ministry of New and Renewable Energy.

Operations

A typical HPS plant has a capacity of 25-50 kW and serves between 200–600 households, 5–10 irrigation pump-sets and small businesses across 2–4 villages within a radius of 2 km (to keep the voltage drop and losses to acceptable levels). Electricity is supplied for 6–8 hours a day and the pre-dominant demand (>60%) is for two lights and mobile charging (30W). A small proportion of consumers have higher demands to power other household needs such as fans, televisions, refrigerators, etc. The tariff is based on demand/wattage with 4–5 different slabs for different levels of demand. Household consumption is monitored and controlled through pre-paid meters, where the service is disconnected automatically when the meter balance reaches zero.

The primary fuel in an HPS plant is rice husk, which has a calorific value of approximately 3,400 kCal/kg. Rice husk has a low bulk density and as a result, transportation over long distances is uneconomical. HPS therefore sources its required resource supply within a radius of 10–20 km from its plant. Each 32 kW gasifier requires approximately 50 kg of rice husk per hour or 12,000 kg rice husk per month, assuming 8 hours of operation per day.

Each plant is managed by a site manager/entrepreneur and engages three full-time and 5–10 part-time workers. Rigorous daily, weekly, and monthly maintenance schedules are followed to ensure

high levels of plant performance (> 93%). In addition, several hundred women are engaged in incense stick making from the residual biochar.

Revenues and Costs

Each plant generates three streams of revenues – income from the sale of electricity, monetising the carbon offsets, and the by-product biochar. Each household pays a connection fee of USD 2–3 and a monthly minimum fee of USD 2-2.50 towards electricity supply for two lights and one mobile charging point (30W) for a period of 6–8 hours. Some households pay higher monthly fees (USD 4–4.50) for higher demands (75–100W). The resultant average monthly revenue from the sale of electricity in a 32 kW plant is USD 1,200. In addition, the average annual carbon credits are approximately 215 CERs and the average monthly sale of incense sticks from biochar is 6 tons.

The capital cost of the overall solution, including installation, works out to less than USD 1,300/kW, of which approximately 20% is covered by a government subsidy, while the operating cost is estimated to be less than USD 0.15/kWh. The typical monthly operating costs for a 32 kW plant works out to approximately USD 760, with approximately 50% going towards labour, around 35–38% towards biomass feedstock, and the balance towards maintenance.

The typical payback period for a plant is between 6–8 years and the gross margin at the plant level is around 20–25%. Sale of carbon credits and sale of biochar towards incense stick making is expected to increase the total revenues and improve the viability of a plant.

Impacts and Benefits

In addition to providing reliable electricity services to rural communities at affordable prices, HPS also provides direct employment to over 350 people in its current portfolio of plants. It further opens up income generating opportunities through incense stick making, etc., where a family can earn up to USD 1.25/day. HPS plants also promote economic development in the local communities by enabling businesses to operate after dark and allowing children to study at night. Further, a typical HPS plant leads to the saving of 42,000 litres of kerosene and 18,000 litres of diesel per year, which translates to a saving of USD 50 per household per year. HPS also leverages its presence in the communities to act as a channel for promoting and marketing other products from several companies and foundations.

Lessons Learned

- ✓ HPS has established the business case for delivery of basic electricity services through a biomass gasifier based mini-grid solutions, but the business is extremely sensitive to cost fluctuations. Further, projected revenue streams from sale of carbon credits and sale of by-products, have not materialised as per expectations.
- ✓ HPS achieved its greatest success as a fully integrated micro-utility addressing all aspects of ownership and operations under the BOOM model. During this period, while the rate of

scale-up was gradual, HPS was successful in raising the necessary investments from international investors. Subsequent rapid scale-up efforts under the BOM and BM models have not been as successful as expected, primarily on account of the inability of the local entrepreneur to raise the necessary capital. It may therefore be prudent to look at variants of the BOOM/BOM model, which may not be amenable to rapid scale-up, but allows for better access to the necessary capital, with replication through several such micro-utilities for widespread impact.

- ✓ HPS has developed rugged, easy to operate, and low cost technology, and created a standard model that allows for some economies of scale (in system design, for example) while remaining flexible to local market conditions.
- ✓ Availability and price of the biomass feedstock continues to pose challenges at the operational level.
- ✓ While the threat of the grid reaching HPS sites has not been significant in the context of the poor electrification rates in Bihar, this still poses a threat in the future and hinders the process of raising capital for future expansion of the model. Efforts are currently being made to look at ways to protect the investment of the private investor from the threat of the grid, including interconnection of such mini-grids to the main grid with appropriate feed-in tariffs, compensation to the investor towards the sunk investments, etc. However, there is little clarity on the timeframe within which such policy and regulatory framework will be established.