Mini-grid development in rural India

Review of the business case, October 2017

Leadership Team
Jaideep Mukherji, Chief Executive Officer, Smart Power India

SPI Core Team
Sidhartha Vermani, Director Strategy and Development
Navdeep Gupta, Program Manager
Nidhi Bali, Program Manager
Gaurav Kawatra, Portfolio Manager
Deepthy Menon, Communications Lead

Advisory Team
Deepali Khanna, Director, The Rockefeller Foundation
Clare Boland Ross, Associate Director, The Rockefeller Foundation
Phiradol Koopthavonrerk, Program Associate, The Rockefeller Foundation

Photos
Monica Tiwari and Mustafa Quraishi

Photo courtesy
Husk Power Systems and Tara Urja

Cover photo
Reliable power helps Guriya Devi keep her shop open until 11pm and make a profit of around INR 3000 a month.

Contents

Figures

Tables

Acronyms and key terms

SPI	Smart Power India
ESCO	Energy service company
SPRD	Smart Power for Rural Development
H1	January to June of a particular year
W	Watt
kW	Kilowatt
kWh	Kilowatt hour
Ah	Ampere hour
kVA	Kilovolt-ampere

Distributed renewable energy (DRE): Refers to energy produced from small-scale local or on-site power plants that produce energy from renewable sources such as solar, wind, hydroelectric, or biomass. DRE is a decentralized alternative to the government electrical grid, although some types of DRE plants can be set up to buy or sell power to the government grid.

Energy- or electricity-based microenterprise: Refers to small local enterprises which utilize energy/ electricity to carry out their activities, e.g. a local printing enterprise which uses electricity to power its printer.

Renewable energy-based mini-grid: A renewable energy-based mini-grid is defined as a system that uses a renewable energy-based generator (with capacity of 10 kW or more) to supply electricity to a specific set of consumers (e.g. households and/or commercial, industrial, and/or institutional organizations) through a power distribution network.

Anchor-based mini-grid: Anchor-based mini-grids provide electricity to a community for lighting and productive uses as well as to one or more "anchor" customers, which consume a large proportion of the electricity generated. The anchor customer for all current SPRD mini-grids is a telecommunications tower.

Non-anchor mini-grid: Non-anchor mini-grids supply power only to community-based consumers.

Commercial customer: Refers to mini-grid customers who operate a commercial enterprise such as a tailoring shop, a printing shop, or a flour mill and use the mini-grid electricity for commercial purposes.

Household customer: Refers to customers which utilize the mini-grid electricity for household uses.

Productive load: Refers to uses of electricity that lead to economic development. Examples include electricity-based microenterprises, such as a tailoring shop, a photocopy shop, a flour mill and irrigation.

Operating margin: The operating margin is a measure of profitability. It indicates how much of each dollar of revenues is left over after both costs of goods sold and operating expenses are considered.

1 Executive summary

In 2016, the Smart Power for Rural Development (SPRD) program published early evidence on the commercial performance, as well as the challenges, of rural mini-grid businesses.[1] The report analyzed 23 top-cohort plants, which included two operating models:

- Anchor-based mini-grids, which provide electricity to a community for lighting and productive uses, as well as to one or more larger "anchor" business customers, which consume a large proportion of the electricity generated
- Non-anchor mini-grids, which supply power only to community-based consumers for lighting and productive uses, such as printing shops and irrigation.

The analysis for the period of January to June (H1) 2016 revealed average unit-level profit margins of approximately 30% after the first year of mini-grid operation. The report concluded that as the energy service companies (ESCOs) built on their early learning from operating these mini-grid plants, they would continue to find ways to increase revenue and make their technologies and business plans more efficient.

It was expected that the ESCOs would play with all four of the elements that drive revenue: number of customers by customer type, units of power sold by customer type, price by customer type, and on-time revenue collection. Furthermore, controlling the key operating expenses – diesel fuel, especially for the anchor-based mini-grid plants, and labor – would further improve the average unit-level profit margins.

Based on the initiatives of the ESCOs, it was estimated that these mini-grid plants could attain regular profit margins of up to 60%.

This report presents the latest observations and learnings based on an analysis for the period of January to June (H1) 2017. As estimated, the ESCOs in the last few months implemented strategies addressing different business drivers that led to an improvement in plant-level performance.

Anchor-based mini-grids improved the customer mix and depth of consumption by tapping unmet energy demand from community customers. Cost control was also realized through multi-skilling of the existing workforce and reduced diesel costs. These interventions resulted in an increase of operating profit to 49% in H1 2017 from 30% in H1 2016. Going further, the target is to increase the hook-up rate and expand power uptake by the community customers.

[1] Smart Power India, *Expanding Opportunities for Renewable Energy-Based Mini-Grids in Rural India.* Retrieved from http://www.rockefellerfoundation.org/report/expanding-opportunities-renewable-energy-based-mini-grids-rural-india/

Non-anchor mini-grids, during the last year, focused on improving capacity utilization of plants and reducing unit-level staff costs. Interventions led to an increase in operating profit to 35% in H1 2017 from 28% in H1 2016. Nurturing demand through productive load development and appliance ownership augmentation is seen as the key to achieving sustainability for non-anchor plants.

A variation in the non-anchor business model to supply 24x7 electricity as compared to supplying electricity for fixed hours is additionally seen to expand power demand organically.

As a way forward, both the anchor-based and non-anchor models will look to increase adoption and power uptake by community customers, which is currently low. Towards this end, replication of the various demand-generating approaches piloted by Smart Power India, such as development of microenterprises and bundling of energy-efficient appliances, is the need of the hour.

The bulk milk chiller powered by a mini-grid in Shivpura has helped Ajay Yadav become a milk aggregator; he is setting up more bulk chillers to expand his business to other villages.

2 Introduction

Over the last year, the ESCOs have implemented strategies to improve performance at the plant level. These strategies addressed business drivers on the market side as well as on the cost side.

On the market side, the ESCOs pushed for further addition of community customer connections and also tested approaches to improve community electricity uptake, including energy-efficient appliances and attractive pricing packages. In addition, the anchor-based ESCOs significantly altered the customer-consumption mix by reducing supply to telecom towers and unlocking capacity for supply to the community customers. Finally, the ESCOs advanced staff cost reduction initiatives by promoting and training multifunctional field staff.

The plant cohort analyzed, and most notably the anchor-based plants, displayed improvements in operating margins and efficiencies. Going forward, the key common test of both the models will be how well they improve power demand uptake from the village community.

This report distills learnings from the performance improvement initiatives undertaken by the ESCOs and the impact on the plant cohort's operational metrics versus the same period last year (H1 2017 vs. H1 2016).

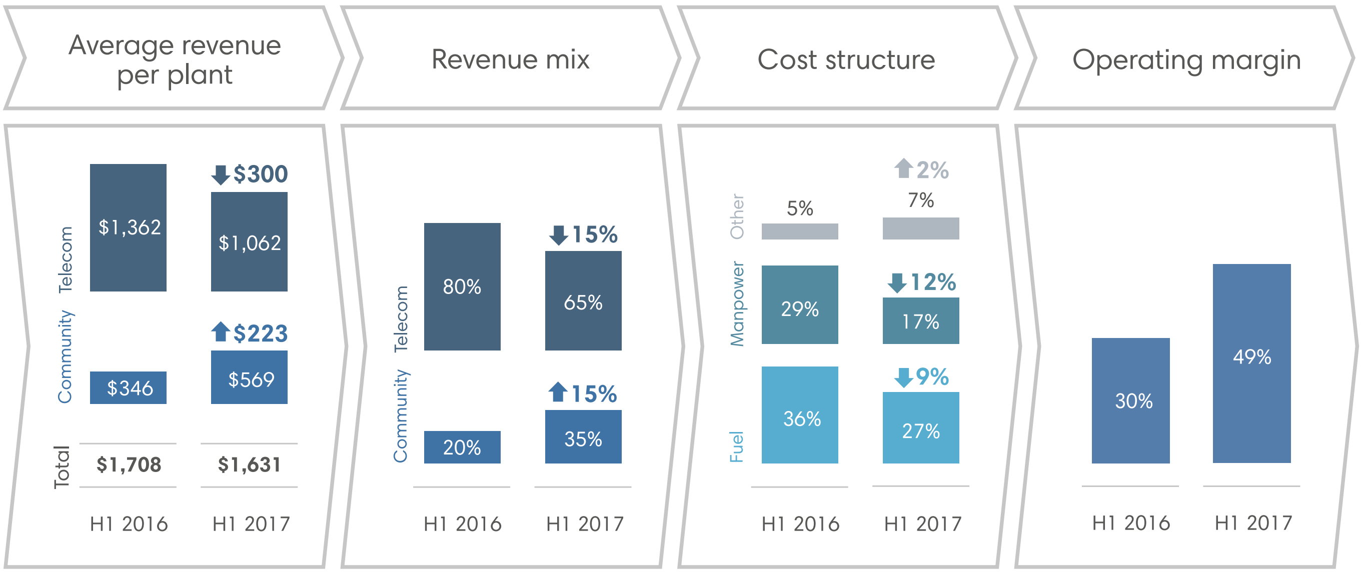
Krishnadev Kushwaha's shoe shop remains open well past sunset with access to reliable power from a mini-grid.

3 Anchor-based mini-grids: Performance improvement interventions

Highlights

- While the total revenue declined, the revenue mix improved and led to an increase in operating profit to 49% in H1 2017 from 30% in H1 2016.
- The average revenue per plant from the community customers increased by 64%, while the revenue and consumption from the anchor customers declined.
- Expenses on manpower and fuel reduced by 44% and 28% respectively.

Figure 1: Improving performance of anchor-based plants, 2016–2017



* Cost structure above reflects the breakdown of the operating ratio, i.e. operating costs as a percentage of total revenues
* Operating margin is the ratio of operating profit to the total revenues
* Exchange rate used for calculations: 1 USD = 65 INR

Table 1: Interventions for better plant performance, anchor-based plants

	IMPROVED CUSTOMER MIX	IMPROVED DEPTH OF CONSUMPTION	CONTROLLED UNIT-LEVEL STAFF COST	CONTROLLED UNIT-LEVEL DIESEL FUEL COST
Issue	High dependence on the anchor telecom customer	Lack of preparedness to meet the latent demand for electricity from existing community customers	High plant-level staff cost	High diesel fuel expense to service the telecom tower load
Strategy	Improve customer connection numbers from within the village community; simultaneously reduce telecom load on mini-grid	Tap into unmet demand for energy from community customers	Promote a multi-skilled existing workforce; reduce expensive security staff outsourcing	Optimize telecom tower load from the mini-grid
Approach	Conducted market survey in the mini-grid catchment to identify new community customers Offered incentives to the selling team to acquire new community customers Enabled connection of telecom towers to central grid supply and freed up capacity to service the community customers	Introduced new price/ capacity package of 100 W load for 24 hours to community households Pilot-tested energy efficient appliances across customer segments to upgrade community customers from basic lighting usage	Discontinued outsourcing of the security function; developed a multi-skilled in-house technical team Trained sales staff to service customer-side technical issues	Analyzed daily telecom tower usage and central grid availability Liaised and coordinated locally to connect telecom towers to the central grid Enabled connection of telecom towers to the central grid
Result	Community customer base increased by 26%	Community customer consumption increased by 45% The average revenue from community customers increased by 30%	Unit-level staff expenditure decreased by 44%	Diesel expense decreased by 28% Freed up capacity to service community customers

Further improvement plan

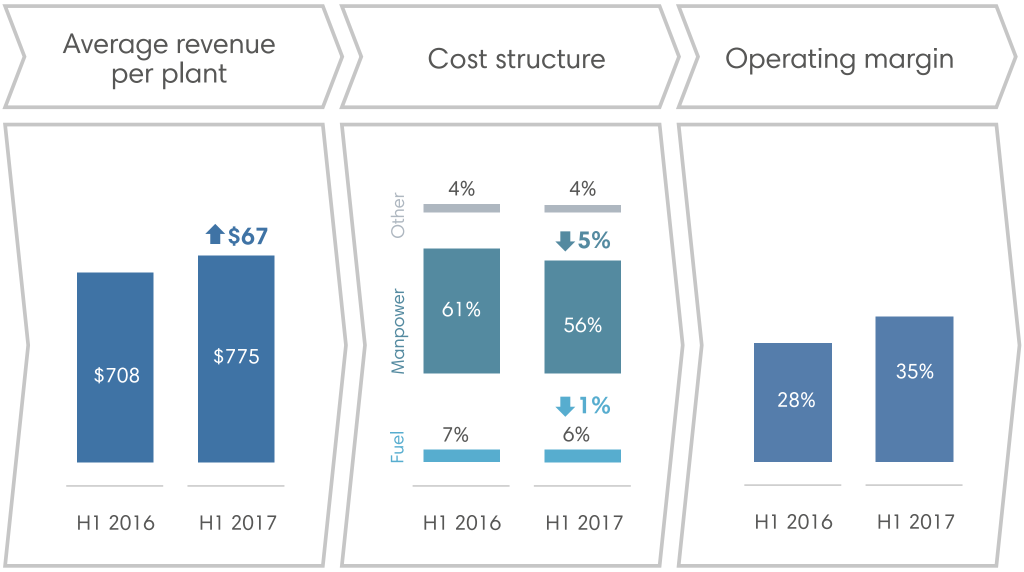
Continuing with this momentum necessitates that the anchor-based plants drive the development of community electricity demand. To this end, the ESCO is targeting an increase in the hook-up rate from the current 68% to 80%. Extension of distribution lines will also be selectively considered. These are all steps in the right direction. Nevertheless, as the anchor-based ESCO increases its focus on servicing a larger number of community customers, expanding the power uptake from individual connections, which currently stands low, will become the priority.

4 Non-anchor mini-grids: Performance improvement interventions

Highlights

- Operating profit of non-anchor plants increased to 35% in H1 2017 from 28% in H1 2016.
- The average revenue per plant increased by 10%.

Figure 2: Improving performance of non-anchor plants, 2016-2017



* Cost structure above reflects the breakdown of the operating ratio, i.e. operating costs as a percentage of total revenues
* Operating margin is the ratio of operating profit to the total revenues
* Exchange rate used for calculations: 1 USD = 65 INR

Access to assured mini-grid electricity enabled Chhathiya Devi to invest in an energy-efficient ceiling fan that provides relief particularly during summer months.

Table 2: Interventions for better plant performance, non-anchor plants

	IMPROVED CAPACITY UTILIZATION	IMPROVED OPERATING MARGIN
Issue	Low plant capacity utilization due to low customer uptake	High unit-level staff cost
Strategy	Interventions to expand community energy usage	Consolidate staff; re-skill existing workforce to perform different functions
Approach	Analyzed consumption pattern of the customers across segments and ascertained higher demand potential for electricity from existing customers Piloted energy efficient appliances across customer segments to increase electricity consumption	Improved recruitment practices; optimized its workforce; trained staff to perform multiple tasks
Result	Improved the quality of customer engagement and service Customer base increased by 15% Average consumption per customer, excluding telecom, increased by 22%	Manpower expense decreased from 61% to 56%

Further improvement plan

For the non-anchor plants, achieving the threshold power demand necessitates incorporating productive load demand development interventions within the operating model. Such interventions could range from supporting agro-based activities, to non-agro, service-based local entrepreneurial activities that require reliable power. Bundling energy efficient appliances with customer connections can also improve appliance penetration and consequently power demand.

A notable model is the 24x7 electricity supply model being implemented by one of the ESCOs, which advances an expansion of demand for organic power from within the village community. This model is explained and its results compared with the traditional community power supply model in the following section.

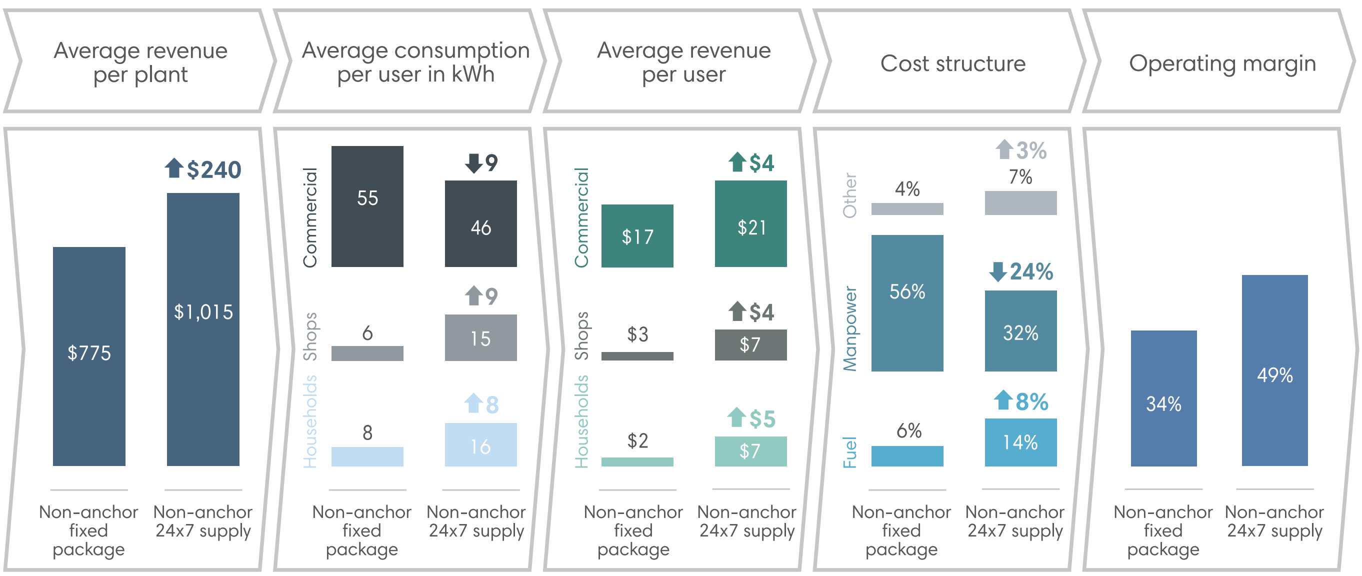
5 Non-anchor mini-grids: 24x7 supply model vs. fixed-package model

Highlights

- The average power consumption per user in the 24x7 supply model is 150% higher for households and 100% higher for shops versus the fixed-package model.
- Consequently, the average revenue per user is 59% higher for households and shops when compared to the fixed-package model.

In the case of a typical non-metered customer connection, both the load and the hours of supply are fixed by the ESCO for a pre-defined pricing/capacity package. In the case of the 24x7 supply model, however, the ESCO fixes the load but offers flexibility to the customer to use electricity as needed. This 24x7 supply model, which offers greater flexibility in electricity usage to the customers, has displayed high organic growth in power uptake from community customers. This consequently leads to higher power consumption and revenue. The model also utilizes biomass technology along with solar, leading to a higher generation potential during non-daylight hours.

Figure 3: Comparing the two non-anchor models



* Cost structure above reflects the breakdown of the operating ratio, i.e. operating costs as a percentage of total revenues
* Operating margin is the ratio of operating profit to the total revenues
* Exchange rate used for calculations: 1 USD = 65 INR

It needs to be noted that there are significant design differences between the two models and migration of an existing fixed-package business to the 24x7 supply model needs careful consideration. Implementation of the 24x7 supply model calls for fundamental transformation of the business including change in the design specifications of plants and equipment, deployment of robust logistics management processes for the biomass feedstock, and re-engineering of the underlying business model as explained in Table 3.

Table 3: Key differences between the 24x7 supply model and the fixed-package model

	FIXED-PACKAGE MODEL OF NON-ANCHOR MINI-GRIDS	24X7 SUPPLY MODEL OF NON-ANCHOR MINI-GRIDS
Design specifications		
Source of generation	Solar and diesel generator	Solar and biomass[1] generator
Solar capacity	33 kW	20 kW
Alternative fuel capacity	15 kVA	32 kVA
Maximum generation potential	~60,000 kWh per year[2]	~200,000 kWh per year[3]
Sizing of the battery bank	1200 Ah	600 Ah
Metering	Unmetered connections may be present	100% connections must be metered
Business model specifications		
Supply hours	Fixed as defined by ESCO for each customer category	24 hours x 7 day supply
Pricing	Fixed monthly pricing packages based on customer category	Pay-as-you-go using smart meters
Payment mode	Pre-paid	Pre-paid

[1] Biomass refers to organic material that is used as a fuel to generate power
[2] Diesel generator up to 30% of total generation
[3] Biomass operations up to 20 hours per day

6 Conclusion

The ESCOs operating under the umbrella of the SPRD program concur that there is an immense scope for further improvement of the business and social performance of the mini-grids. Over the last year, while the anchor-based plants have improved their customer mix and reduced the cost of operations to improve their operating margins, the non-anchor plants have endeavored to achieve the necessary threshold of power demand from the village community.

Looking ahead, the fundamental challenge for both of the models is increasing the adoption and consumption of power by the village community, which at present are low. Economic activity, penetration of basic appliances, and regularity of wages all play an important role in determining adoption and uptake. The ESCO model necessitates the integration of power demand expansion interventions along with managing the supply side.

Over the last year, Smart Power India has pilot-tested approaches with the ESCOs to expand overall energy demand from the village community. Such interventions range from developing power demand from microenterprises to creating new energy-based village-level microenterprises. Smart Power India has also pilot-tested approaches in bundling energy efficient appliances with existing customer connections. The initial results have been promising. Additionally, it is evident from the 24x7 supply model that offering flexibility in the supply hours improves the absolute power off-take by community customers, as was expected.

In the coming months, replicating these approaches to expand community power usage, as well as evaluating ways to integrate such approaches with the ESCO model, will be of great significance.

With the profit Nasreen Banu earns from her spice grinding unit, she can afford to employ another full-time worker and expand her business.

Access to quality power is helping rural entrepreneur Abhijeet Jaiswal run his garment shop without having to worry about power interruptions.

SmartPowerIndia
Powered by The Rockefeller Foundation

CONTACT US

Smart Power India
706, Time Tower
MG Road
Gurgaon 122002
Haryana

+91 124 469 2000
contact@smartpowerindia.org
www.smartpowerindia.org