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Foreword

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Foreword

The energy deprivation cycle continues to pose a major challenge for governments in emerging economies. Electrification has typically been delivered through centralised generation and distribution that was not always afforded equitable or efficient access. Decentralised solar technologies are fast approaching financial parity and have definitively environmental advantages over grid extension, especially in rural and remote locations. UPNEDA has been pioneer in demonstrating the solar mini-grid technology and issuing a Solar Mini-grid Policy.

Mini-grid technologies and service delivery models hold great promise for easier energy accessibility and catalysing rural enterprise development in India; this Handbook represents another promising step for Smart Power India’s leadership in this sector. Uttar Pradesh’s forward-looking policy aims to facilitate different types of mini-grid business models.

As highlighted in this Handbook, the Uttar Pradesh, policy has further encouraged long-term investment in the sector by providing guidelines for mini-grids. Combined with Smart Power India’s extensive practical experience in deploying renewables-based mini-grids, the Handbook paints a comprehensive picture of mini-grid project development.

I am happy to have witnessed a proliferation of different mini-grid models which both supplement and complement the national grid. Realising the transformative potential of mini-grids, I am certain other states will be encouraged by Uttar Pradesh governments initiative in crafting and enabling policy frameworks.

Bhawani Singh Khangarot
21.11.19 Director
In the year 2015, Smart Power India (SPI) embarked on a journey with a vision to drive socio-economic progress of rural customers by ensuring access to reliable and quality electricity. As of November 2019, we have supported 12 developers in building a portfolio of 241 mini-grids in the states of Uttar Pradesh, Bihar, and Jharkhand. These mini-grids cumulatively serve over 2 lakh customers – from households and shops requiring simple lighting, to commercial enterprises, telecom towers, agri-processing, and schools.

In our quest to develop viable mini-grid models, SPI has been constantly innovating to improve technical performance and consumer services. In parallel, our advocacy efforts have sought to promote mini-grids as a promising last-mile energy service solution, harmoniously complements the government’s drive of electrification. Collaborating closely with government agencies, we have highlighted a range of critical issues, and made significant progress on de-risking the mini-grid ecosystem and improving regulatory certainty.

Adequate electricity is an important precursor to economic growth in rural areas. While there has been tremendous progress made in rural electrification, challenges remain in ensuring connections to rural businesses and micro-enterprises.

Mini-grid developers, apart from supplying renewables-based electricity to all types of customers, have played an active role in catalysing the use of electricity for productive economic activity, in promoting energy efficiency, and in supporting communities to meet their social goals in sectors of education (e.g. lighting and appliances for schools) and health (e.g. clean drinking water, digital clinics), among others.

The mini-grid ecosystem continues to mature and evolve, in India and around the globe. This Handbook aims to distil some of SPI’s experiences and expertise in establishing and running a viable mini-grid. It elaborates upon mini-grid services and capabilities, business and financial considerations, and provides guidance for navigating the regulatory landscape. To new entrants in the mini-grid space, as well as to those with established ventures, not just in India but also for other countries, we hope that this Handbook will serve as a standard and effective guide.
Smart Power India (SPI), a subsidiary of the Rockefeller Foundation is the key agency for implementing the Smart Power initiative of the Foundation. SPI extends power to those without sufficient access to end energy-poverty and transform the livelihoods of the under-served. It is working towards building and nurturing ecosystems to promote sustainable and scalable models to deliver electricity access.

**Providing electricity access 241 villages of India**

Impacting the lives of 211,892 people

241 plants across Uttar Pradesh, Bihar and Jharkhand

24,401 Overall customers

7.3 MW Overall installed capacity

97% plants use solar energy

3% use biomass or solar/biomass hybrid technology

15,554 Households

6,747 Shops

1,912 Commercial users & micro-enterprises

132 Telecom towers

56 Institutions

As of October 2019

*1912 includes 1730 commercial and 182 micro-enterprises*
1. Introduction .................................................................................................................. 09

2. Mini-grids in India ......................................................................................................... 13
   2.1. Basics of Mini-grids .............................................................................................. 14
   2.2. Benefits of Mini-grids ......................................................................................... 14
       Box 1: Why Customers Choose Mini-grids .............................................................. 15
   2.3. Customer Profiles ............................................................................................... 15
   2.4. Operating Models ............................................................................................... 16

3. Project Development ..................................................................................................... 19
   3.1. Phases of Planning and Operation ...................................................................... 20
   3.2. Selection of Villages ........................................................................................... 20
       3.2.1. Selection Criteria ......................................................................................... 21
       3.2.2. Detailed Energy Assessment ..................................................................... 21
   3.3. Selection of Technology ..................................................................................... 22
       3.3.1. Hybrid Generation ...................................................................................... 23

4. Business Viability .......................................................................................................... 25
   4.1. Cost Assessment .................................................................................................. 26
       4.1.1. Capital Expenditure ..................................................................................... 26
       4.1.2. Operational Expenditure ............................................................................. 27
       Box 2: Mini-grid Cost Break-down ...................................................................... 28
   4.2. Revenue Potential Maximisation ........................................................................ 28
       4.2.1. Levels of Service ......................................................................................... 29
       4.2.2. Connection Types and Metering Strategies .................................................. 29
       Box 3: Smart Meters .............................................................................................. 30
       4.2.3. Tariff Models ................................................................................................ 31
       4.2.4. Collecting Payments .................................................................................... 31
       Box 4: Tara Urja’s Customer Management Platform ........................................... 32
       Box 5: Solar Mini-grids and Supply Timings ......................................................... 32
   4.3. Load Acquisition .................................................................................................. 32
       4.3.1. Customer Acquisition ................................................................................ 33
       4.3.2. Demand Conversion .................................................................................... 34
       4.3.3. Demand Enhancement ................................................................................ 34
       Box 6: Energy Efficient Appliance Schemes ......................................................... 35
   4.3.4. New Demand Creation ................................................................................... 35
       Box 7: Water Treatment Units ................................................................................ 36
       Box 8: Oil Expeller Units ....................................................................................... 36
   4.4. Key Considerations .............................................................................................. 36
5. Financing Mini-grids

5.1. Mechanisms and Sources of Finance

Box 9: Grant-Funded Mini-grids
Box 10: IREDA Loan Scheme for Mini-grids
Box 11: Debt Funding from the Rockefeller Foundation
Box 12: Major Equity Deals in the Mini-grid Sector

5.2. Evolving Funding Strategies

Box 13: Crowdfunding

6. Policy and Regulatory Landscape

6.1. An Enabling Environment for Mini-grids
6.2. Central Government Measures
6.3. State Government Measures
6.3.1. Uttar Pradesh
6.3.2. Bihar
6.4. Approvals Required

7. Business Risks

7.1. Challenges, Impacts, and Mitigation Measures

Box 14: Technology Risks and Warranties

8. Impact of Mini-grids

Annexure
A. Legislation, Policy, and Regulation
B. Policies and Regulations in Uttar Pradesh and Bihar
C. Approvals and Clearances
   Box 15 - Waiver of Approvals and Clearances
D. Funding Agencies

Glossary
1

Introduction

Transforming last-mile electricity delivery with mini-grids
India connected all willing households to the electricity grid in early 2019. This achievement was the result of ambitious and consistent efforts from Central and State Governments to drive rural electrification via public and private distribution companies (DISCOMs).

Laying this infrastructure backbone can be considered as an inflection point in the energy access narrative in India, and momentum is now being directed towards the next critical milestones:

i. Expanding service to productive rural loads
ii. Ensuring provision of reliable power supply to all loads

This next phase of India’s strategy must consider the potential of distributed renewable energy (DRE) mini-grids, developed and operated by Energy Service Companies (ESCOs). There is growing recognition that these are uniquely positioned to play an important and complementary role in improving last-mile electricity service delivery: for example, The Ministry of Power’s Power for All¹ and Niti Aayog’s Strategy for New India @ 75² encourage deployment of DRE-based mini-grids, as they:

- **Allow flexibility in services and tariffs** – Standalone mini-grids allow customisation of the services and tariffs as per local needs and socio-economic conditions

- **Allow investments from various sources** – Mini-grids can combine diverse funding sources, including customers, private equity, aid agencies, and government

- **Reduce need for large infrastructure** – Generation and loads are co-located, reducing the need for transmission infrastructure and eliminating associated power losses

- **Interface with utility-scale grids** – Mini-grids have been deployed both in villages not connected to DISCOM grids, and as complementary power sources in grid-connected villages

- **Mobilise local resources** – Reliable power combined with institutional know-how of mini-grid developers can unlock latent demand and entrepreneurship in rural areas

- **Stimulate rural livelihoods** – Local human resources can be deployed in technical and commercial activities associated with the mini-grid, simultaneously creating employment and building local capacity

- **Promote energy efficiency** – Co-location of generation and consumption reduces technical losses, and ESCOs will further ensure that their systems operate efficiently

- **Environmentally friendly** – Renewable energy technology and energy conservation practices reduce fossil fuel consumption and local pollution

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¹Further information on the Ministry of Power’s website https://powermin.nic.in/en/content/power-all.
Central and State Government measures have been enacted to facilitate mini-grid development: India now boasts over 2800 mini-grids operating in rural areas, many of which are built and operated by private entities with support from government agencies. Indeed, enabling private investment and entrepreneurship will be instrumental in rapidly developing efficient electricity systems in countries across the globe.

The fact that consumers connect to mini-grids in spite of the availability of alternatives is testament to the reliability and quality of mini-grid power, the advantages of customised energy packages, and ESCOs’ commitment to responsive customer service. Another important contribution has been active promotion of village development through energy access, including provision of support to local business entrepreneurs, and social services like provision of clean drinking water.
Mini-grids in India
Characterising mini-grids and the customers they serve
2.1 Basics of Mini-grids

Mini-grids are electricity distribution systems comprising generation sources (e.g. solar panels, biogas plant), and a distribution network to deliver power to customers. A typical rural mini-grid distribution network extends 1-2km from the plant, allowing it to service 100-140 households, 50-60 shops, and a mix of productive users.

A model mini-grid is captured in Figure 1.

![Figure 1: Schematic of a mini-grid](image-url)

2.2 Benefits of Mini-grids

While India has recently witnessed astonishing progress in grid connectivity, there remain opportunities for mini-grids to bring value to both domestic and commercial consumers. To realise this potential, mini-grids must demonstrate to both existing and prospective electricity consumers that they offer tangible benefits over alternative (possibly cheaper) energy sources such as kerosene lamps, diesel generators, solar home systems, rechargeable batteries, and the government grid. The drivers of customer satisfaction—and hence their willingness to pay for a mini-grid connection—are described in Box 1, which constitutes the "customer service mantra" for mini-grid developers.
2.3 Customer Profiles

A village typically consists of several types of consumers, each with different levels of demand and consumption patterns which vary on daily and annual bases. Characteristics of the main consumer types are outlined in Table 1.

### Table 1: Typical electricity consumers in a village

<table>
<thead>
<tr>
<th>Consumer</th>
<th>Examples of usage</th>
<th>Load</th>
<th>Timing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Households</td>
<td>Basic lighting, mobile charging, fans, appliances like refrigerators and televisions</td>
<td>20-350W</td>
<td>From 5 hours per day to 24 hour per day</td>
</tr>
<tr>
<td>Shops</td>
<td>Basic lighting, mobile charging, fans</td>
<td>20-100W</td>
<td>From 12 to 14 hours per day</td>
</tr>
<tr>
<td>Commercial – Appliances</td>
<td>Grocery shops with refrigerators, mobile repair shops, photo studios and cyber cafes, vehicle repair shops, private clinics, tailoring shops, cold storage units, poultry farms</td>
<td>100W-4kW</td>
<td>From 6 hours per day to 24 hours per day (e.g. refrigerators)</td>
</tr>
<tr>
<td>Commercial – Motors</td>
<td>Flour mills, rice mills, oil extractors, masala grinders, irrigation pumps, water treatment units</td>
<td>1.5-6kW</td>
<td>From 2 hours per day to 12 hours per day (e.g. irrigation)</td>
</tr>
<tr>
<td>Commercial – Institutions</td>
<td>Banks, ATMs, post offices, hospitals, schools, government offices, community centres, police stations, petrol pumps, telecom towers</td>
<td>150W-4kW</td>
<td>From 8 hours per day to 24 hours per day (e.g. telecom towers)</td>
</tr>
</tbody>
</table>

Box 1: Why Customers Choose Mini-grids

- **Quality and reliability of power.** Mini-grids must ensure dependable uninterrupted service, at a voltage sufficient to run customers’ appliances
- **Packages tailored to local needs.** A variety of package options with a range of tariffs, load levels, and timings will satisfy customers that they are paying for what they need
- **Responsive customer service.** Agents are available to resolve technical problems, assist with package changes, and spread information about promotions, in order to maintain high customer engagement
- **Investment in local community.** ESCO’s support access to appliances for customers—both household and commercial—which channels investment into the local community
2.4 Operating Models

A mini-grid developer may choose from a variety of operating models depending on their capital constraints, target consumer segments, and geographical focus. These models present inter-related trade-offs which affect the overall riskiness of a project, the operational challenges it will encounter, and ultimately the returns in terms of profits and other forms of impact.

The following are three principal mini-grid operating models:

1. **Anchor.** An anchor load is a high-consumption customer whose reliable energy demand throughout the year ensures a consistent baseline of plant utilisation. Typical anchors are institutional consumers, or commercial consumers such as telecom towers. In anchor-based operating models, one or more anchors are combined with other loads such as households, shops, agriculture, and commercial.

2. **Community.** A community-based operating model is essentially one which does not have any anchor load.

3. **Grid-connected.** Mini-grids connected to the grid may sell surplus power to the DISCOM. This will ensure high plant utilisation, while developing alternative revenue sources. Grid-connected operating models mitigate the risks of oversizing the generating unit and low local demand levels. (A few states are developing guidelines for interconnectivity; some existing provisions are addressed in Chapter 6.)

Selection of an operating model depends on several factors like the ESCO’s impact targets and desired return-risk profile. A few generic considerations are illustrated in Figure 2.

**Figure 2: Key considerations in operating model design**

<table>
<thead>
<tr>
<th>Consumer reliability</th>
<th>Customers needed</th>
<th>Revenue per unit sold</th>
<th>Goals and impact</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Meaning:</strong> Level of month-on-month variability in consumers’ electricity demand</td>
<td><strong>Meaning:</strong> Number of customers needed for project viability</td>
<td><strong>Meaning:</strong> High-demand customers increase aggregate revenue, but are able to negotiate cheaper tariffs, reducing revenue per unit sold</td>
<td><strong>Meaning:</strong> ESCOs aiming for social impact operate in more marginal areas with low and uncertain demand</td>
</tr>
<tr>
<td><strong>Impact:</strong> High variability → uncertain and fluctuating revenue, which reduces viability</td>
<td><strong>Impact:</strong> Focus on low-demand consumers requires greater efforts in recruitment and demand enhancement</td>
<td><strong>Impact:</strong> Trade-off between customer dependability and costs</td>
<td><strong>Insight:</strong> ESCOs must balance pursuit of development goals against project financial viability</td>
</tr>
</tbody>
</table>

Table 2 and the commentary that follows briefly profile different consumer types according to the considerations in Figure 2. In practice, a mini-grid may serve a combination or all these types.
Table 2: Characteristics of different customer types

<table>
<thead>
<tr>
<th>Customer type</th>
<th>Household</th>
<th>Shop</th>
<th>Commercial</th>
<th>Anchor</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Description</strong></td>
<td>Connections for lighting and basic appliances</td>
<td>Cluster of marketplace shops and stalls</td>
<td>Productive enterprises with regular operation</td>
<td>Primary high-load customer</td>
</tr>
<tr>
<td><strong>Consumer Reliability</strong></td>
<td><img src="#" alt="Score" /></td>
<td><img src="#" alt="Score" /></td>
<td><img src="#" alt="Score" /></td>
<td><img src="#" alt="Score" /></td>
</tr>
<tr>
<td><strong>Customers Needed</strong></td>
<td><img src="#" alt="Score" /></td>
<td><img src="#" alt="Score" /></td>
<td><img src="#" alt="Score" /></td>
<td><img src="#" alt="Score" /></td>
</tr>
<tr>
<td><strong>Revenue Per unit sold</strong></td>
<td><img src="#" alt="Score" /></td>
<td><img src="#" alt="Score" /></td>
<td><img src="#" alt="Score" /></td>
<td><img src="#" alt="Score" /></td>
</tr>
<tr>
<td><strong>Local impact</strong></td>
<td>Improving social indicators</td>
<td>Easing rural livelihoods</td>
<td>Supporting entrepreneurs</td>
<td>Facilitating local services</td>
</tr>
<tr>
<td><strong>De-risking Strategy</strong></td>
<td>Appliance promotion</td>
<td>High customer adoption rate</td>
<td>Business development</td>
<td>High quality of power</td>
</tr>
</tbody>
</table>

- **Household & Shop.** These customers will typically have modest energy requirements: therefore, high density of potential customers in the catchment area is desirable, along with robust marketing strategies to achieve high penetration. Household appliance promotion schemes can improve revenues by leveraging latent demand and driving customer acquisition (this is detailed further in Section 4.3.3). Impact-wise, these models emphasise social development.

- **Commercial.** A range of enterprises with high-load appliances and motors can benefit from a reliable power supply. Mini-grid developers should facilitate expansion of productive loads, which may have previously been unviable due to local capital constraints or absence of reliable electricity (this is detailed further in Sections 4.3.2 and 4.3.4). Impact-wise, this model drives economic development hand in hand with electricity consumption.

- **Anchor.** This model mitigates risk of under-recovery and variation in demand, but negotiating higher-volume energy sales typically reduces revenue per unit sold. Furthermore, anchors with exacting service requirements necessitate higher upfront investment (e.g. in batteries) or operational expenses (e.g. on diesel generators), while also reducing bandwidth for serving other customers. Overall, the anchor-based operating model is typically the safest.
Project Development

Selecting a site and operating model – key factors in project success
3.1 Phases of Planning and Operation

There are three over-arching phases of project development: planning, implementation, and operation. These are summarised in Figure 3.

This chapter focusses on the first phase, which comprises the selection of villages to site the project, and appropriate power generation technologies.

3.2 Selection of Villages

Promising villages can be shortlisted through a combination of desk research and preliminary field visits. To narrow this list further and select villages for project go-ahead, the shortlist must undergo careful survey to assess demand and other factors which inform technology selection and profitability estimates. The process and methods of assessment is outlined in Figure 4.
3.2.1 Selection Criteria

Each stage of the selection process requires some decision-making based on pre-defined parameters and according to pre-defined criteria. These parameters and criteria naturally become more granular and detailed as selection progresses – for instance, at the state level, an ESCO may consider the aggregate statistics about the rural population, whereas during the detailed survey they would investigate the geographical spread of households and hamlets within a village.

Key assessment parameters (in no particular order of priority) are summarised in Table 3.

<table>
<thead>
<tr>
<th>Table 3: Village selection parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regulatory environment</td>
</tr>
<tr>
<td>ESCO preference</td>
</tr>
<tr>
<td>Population density</td>
</tr>
<tr>
<td>Economic status</td>
</tr>
<tr>
<td>Electrification status</td>
</tr>
<tr>
<td>Energy alternatives</td>
</tr>
<tr>
<td>Demand level</td>
</tr>
<tr>
<td>Demand profile</td>
</tr>
<tr>
<td>Willingness to pay</td>
</tr>
<tr>
<td>Presence of anchors</td>
</tr>
<tr>
<td>Clustering potential</td>
</tr>
</tbody>
</table>

3.2.2 Detailed Energy Assessment

Thorough energy demand profiling is required for finalising project design, developing service packages, and assessing financial feasibility. Profiling should include the parameters listed in Table 3, along with items such as the range and number of household and commercial appliances in use.
A detailed questionnaire must be developed for on-ground interviews with various stakeholders. Executing such an activity requires a high level of expertise and local familiarity: it is therefore recommended to hire a local surveying agency.

### 3.3 Selection of Technology

Mini-grids in India are largely solar-based, though biomass is also a viable generation source. A comparison is presented in Table 4. Other technologies include small hydro and wind power, but these are scarce in most parts of India.

#### Table 4: Comparison of solar and biomass generation technologies

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Solar</th>
<th>Biomass</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Modularity</strong></td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>A large variety of equipment options are available which can be easily combined</td>
<td>Primary components (gasifiers, boilers, turbines) are available in limited sizes and cannot be easily combined</td>
</tr>
<tr>
<td><strong>Availability of resources</strong></td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Solar irradiance is high across most parts of India</td>
<td>Biomass is available in most rural areas</td>
</tr>
<tr>
<td><strong>Intermittency</strong></td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>PV generates only during daytime, and output fluctuates with weather</td>
<td>Generation is possible at any time if suitable biomass is available</td>
</tr>
<tr>
<td><strong>Capital investment</strong></td>
<td>High</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Capital investment constitutes a large part of life-time expenses</td>
<td>Capital investment forms a small part of life-time expenses</td>
</tr>
<tr>
<td><strong>Fuel linkages</strong></td>
<td>None</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>No fuel linkages are required</td>
<td>Generation is dependent on variable biomass supply</td>
</tr>
<tr>
<td><strong>Need for back up</strong></td>
<td>High</td>
<td>Low to medium</td>
</tr>
<tr>
<td></td>
<td>Diesel generator required for plugging gaps between demand and intermittent/fluctuating generation</td>
<td>Back up of diesel generator only required to address intermittent shortages in fuel supply</td>
</tr>
<tr>
<td><strong>Maintenance</strong></td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Only cleaning and monitoring</td>
<td>Engine requires periodic servicing</td>
</tr>
<tr>
<td><strong>Complexity of design</strong></td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>Solar feedstock (irradiance) is fairly predictable and uniform</td>
<td>Different types of biomass, seasonality, moisture content, and storage require consideration</td>
</tr>
</tbody>
</table>
Hybrid Generation

Hybrid mini-grids which draw on complementary generation sources are also possible: for example, using solar to supply day-time load and biomass to supply evening and night-time load. This strategy reduces both biomass consumption and battery requirements.

It is common practice for solar mini-grids to use back-up diesel generators serve three distinct purposes:

1. Maintain power supply to customers in the case of technical faults;
2. Cover intermittent shortfalls in supply (see Table 4);
3. Avoid excessive capital investments for meeting transient / seasonal demand peaks (see Section 4.3).
4

Business Viability

Managing profitability by optimising costs and maximising revenues
4.1 Cost Assessment

The lifetime costs of a mini-grid depend on various aspects of project design like the technology selected, the size of the project, and the services offered. At the same time, costs also influence technology selection, feasible service offerings, and project risks.

Costs can be broadly classified into capital expenditures and operational expenditures: these are summarised in Figure 5 and elaborated thereafter.

**Figure 5: Mini-grid cost drivers**

<table>
<thead>
<tr>
<th>Capital expenditure</th>
<th>Operating expenditure</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Generation unit</td>
<td>• Maintenance, monitoring, security</td>
</tr>
<tr>
<td>• Distribution infrastructure</td>
<td>• Fuel</td>
</tr>
<tr>
<td>• Customer consumption monitoring</td>
<td>• Customer service, billing, collection</td>
</tr>
<tr>
<td>• Plant monitoring</td>
<td>• Land rent</td>
</tr>
</tbody>
</table>

4.1.1 Capital Expenditure

Capital expenditures are the costs associated with building mini-grid assets. As discussed in detail in Section 4.3, high capital expenditures will affect the risk-return profile of the project. The various aspects of capital expenditure outlined in Figure 5 are elaborated below, with an indicative cost breakdown in Box 2.

1. **Generation unit**
   Cost of the generation unit—including generation sources, energy storage, power electronics, and balance-of-system components—is a major contributor to project capital expenditure. This cost is dependent on the technology selected and the services provided.

2. **Distribution infrastructure**
   Distribution infrastructure includes cables, poles, and other equipment required to connect customers. The number and geographical spread of customers dictates the aggregate cost. Mini-grid developers should aim to minimise costs by siting their plants close to the loads.

3. **Customer consumption monitoring**
   Monitoring customer consumption is essential for accurate billing, understanding usage patterns, identifying theft, and controlling loads placed on the plant. (Details will be discussed in Section 4.2.2.)
4. **Plant monitoring**
Gathering data about the operational performance of mini-grids allows the developer to identify system inefficiencies and emerging faults, and to correct any design flaws. Strategies range from basic manual monitoring to more expensive remote real-time centralised monitoring.

5. **Project development costs**
This includes requisite up-front activities like surveying villages, acquiring permits and approvals, and plant design.

4.1.2 **Operational Expenditure**
Operational expenditures consist of the ongoing costs of running and maintaining the system, and servicing customers. It is important to carefully project and monitor operational expenditures, and hold a few months of reserve as working capital. The various aspects of operational expenditure outlined in Figure 5 are elaborated below, with indicative cost data presented in Box 2.

1. **Maintenance, monitoring, security**
   On-ground personnel presence is required for various tasks including:
   a. Securing the plant
   b. Equipment monitoring and record-keeping
   c. Maintenance and repair of plant and distribution network

2. **Fuel**
   Biomass-based electricity generation requires fuel, while other technologies like solar and hydro may require fuel indirectly if they use diesel generators as back-up.

3. **Customer service, billing and collection**
   Personnel are required to service requests and complaints of existing customers, recruit new customers, generate bills, and carry out collections. The manpower requirement is highly specific to local conditions and services offered (for example, prepaid metering reduces billing and collection burdens compared to conventional metering).

4. **Land rent**
The project will require a multi-year lease for land which can be developed into the plant site.
## Box 2: Mini-grid Cost Break-down

Typical capital and operational costs are presented for a viable 30 kWp solar plant with batteries and diesel back-up. The mini-grid build costs INR 4.2-5.1 million. An indicative break-up is provided in Figure 7.

Recurring expenses range from INR 14-18 thousand per month. An indicative break-up of this is shown in Figure 8.

### Note:
- The operational expenses mentioned are indicative for the first year. Expenses are likely to increase over the life of the project.
- Fuel cost is highly variable, and depends largely on the plant’s utilisation level: above 75%, diesel usage will grow significantly.

### Figure 7: Capital expenditures for a typical 30 kWp solar mini-grid

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planning and design</td>
<td>5%</td>
</tr>
<tr>
<td>Diesel generator</td>
<td>5%</td>
</tr>
<tr>
<td>Buildings and fencing</td>
<td>10%</td>
</tr>
<tr>
<td>Distribution infrastructure</td>
<td>20%</td>
</tr>
<tr>
<td>Battery unit</td>
<td>20%</td>
</tr>
<tr>
<td>Solar generating unit</td>
<td>40%</td>
</tr>
</tbody>
</table>

### Figure 8: Operational expenditures for a typical 30 kWp solar mini-grid

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land rent</td>
<td>2-3%</td>
</tr>
<tr>
<td>Fuel</td>
<td>10-20%</td>
</tr>
<tr>
<td>Maintenance</td>
<td>25-30%</td>
</tr>
<tr>
<td>Manpower</td>
<td>50-60%</td>
</tr>
</tbody>
</table>

### 4.2 Revenue Potential Maximisation

This section covers major considerations for designing electricity packages and tariffs. These encompass both business drivers and technologies which enable different functionalities and service options.

A mini-grid project should generate enough revenue to meet the business requirements outlined in Figure 8. Careful revenue planning is necessary to demonstrate project viability to potential investors.

### Figure 8: Revenue targets and obligations throughout mini-grid project life

<table>
<thead>
<tr>
<th>Short term</th>
<th>Medium term</th>
<th>Long term</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Cover operational expenses</td>
<td>• Build cash reserves for contingency asset</td>
<td>• Provide returns to equity investors</td>
</tr>
<tr>
<td>• Build cash reserves for routine maintenance</td>
<td>replacement</td>
<td>• Create evidence base of viability for future investment</td>
</tr>
<tr>
<td>• Pay interest on loans</td>
<td>• Pay back loan principal</td>
<td></td>
</tr>
</tbody>
</table>
Service package design is the ESCO’s most direct lever for maximising revenue within the constraints of customer paying capacity and installed generation capacity. Three key design inputs are:

1. Levels of service provided
2. Metering strategies and technologies
3. Tariff and payment models

These three inputs and their inter-dependencies will be developed in the following sections.

4.2.1 Levels of Service

From the customer’s perspective, there are three dimensions of electricity access:

1. **Timing and duration of supply**
   - e.g. three hours each evening for basic lighting, or continuous 24-hour connection for refrigeration loads

2. **Maximum instantaneous power they can draw**
   - e.g. 17W for basic lighting, or 5kW for an irrigation pump

3. **Cumulative energy allowance per billing period**
   - e.g. five units per month for a household, or unlimited with bills every month for a water treatment enterprise

Each one of these can be tailored to a customers’ demands and usage patterns, ultimately creating suitable packages that they will be willing to pay for.

4.2.2 Connection Types and Metering Strategies

Managing connections requires the ESCO to choose an appropriate metering technology from those introduced in Table 5. Implications for tariff design are discussed in the following section.

<table>
<thead>
<tr>
<th>Table 5: Characteristics of different customer types</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connection type</td>
</tr>
</tbody>
</table>
| Load limit | Power | • Low-cost device  
• Low personnel burden  
• Allows pre-paid tariffs  
• Avoids excessive load on plant | • Unsuitable for customers with high or erratic demand  
• Limited management functionality  
• Cannot calculate distribution loss  
• Failure permits unlimited consumption  
• Time-of-day tariff not possible | Basic lighting and mobile charging |
<table>
<thead>
<tr>
<th>Connection type</th>
<th>Parameter monitored</th>
<th>Advantages</th>
<th>Disadvantages</th>
<th>Typical user</th>
</tr>
</thead>
</table>
| **Meter**       | Energy              | • Billing directly relates to consumption  
• Permits distribution loss calculation  
• Tamper-proof models available | • Requires routine meter reading  
• Cannot moderate current surges  
• Limited management functionality  
• Time-of-day tariff not possible | Moderate-load appliances and heavy commercial loads |
| **Meter + load limit** | Power + Energy | • Enables billing on both energy and power  
• Permits distribution loss calculation  
• Tamper-proof models available  
• Avoids excessive load on plant | • Requires routine meter reading  
• Limited management functionality  
• Time-of-day tariff not possible | Moderate-load appliances |
| **Smart meter** | Power + Energy | • Enables billing based on energy and power  
• All parties can track in real time  
• Automation→low personnel burden  
• Detailed customer data  
• Time-of-day programmability  
• Tamper/theft alerts  
• Remote connection management  
• Automatic disable upon non-payment | • Costly devices  
• Monthly user fees | All (see Box 3) |

**Box 3: Smart Meters**

SPI’s partner ESCOs are increasingly keen to integrate smart meters into their regular operations, as the technology’s functionalities, familiarity, and accessibility grows.

The potential of smart metering (see Table 5) is realised when a mini-grid site gets full coverage, such that customer service and management functionality and electricity package options become uniformly streamlined. Full coverage also allows ESCOs to build a comprehensive picture of the quality of power delivered, technical distribution losses and faults, and power theft.

However, existing state-of-the-art metering solutions suitable for mini-grid contexts are currently expensive, and it may take three years for cost savings to accrue from rural customers who provide limited revenue.
4.2.3 Tariff Models

The tariff models employed in the mini-grid sector are summarised and illustrated in Table 6. The preferred model will depend on customer usage requirements as well as the chosen metering technology.

<table>
<thead>
<tr>
<th>Mode</th>
<th>Description</th>
<th>Example</th>
<th>Prerequisites</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-paid (power)</td>
<td>Customer pays for a fixed load limit in advance</td>
<td>Basic package of INR 150 per month for 20W connection</td>
<td>Load limiter</td>
</tr>
<tr>
<td>Pre-paid (energy)</td>
<td>Customer pays for a fixed energy allowance in advance</td>
<td>Advance monthly payment of INR 800 for 40 units</td>
<td>Smart meter</td>
</tr>
<tr>
<td>Post-paid</td>
<td>Customer pays for the energy consumed in the billing period</td>
<td>Customer pays INR 25 per unit consumed</td>
<td>Meter or smart meter</td>
</tr>
<tr>
<td>Mix-mode</td>
<td>Customer pays for a fixed load limit and energy allowance in advance; consumption in excess of allowance settled at end of billing period</td>
<td>INR 1000 per month in advance for 40 units and a load limit of 2kW, with charge of INR 20 per unit beyond allowance</td>
<td>Smart meter</td>
</tr>
</tbody>
</table>

4.2.4 Collecting Payments

Billing and collection activities are facilitated by a strong community presence. This can be achieved through a combination of recruiting local staff, and engaging local organisations (like NGOs) and institutions (like gram panchayats).

Delays in receiving payments from customers, or piece-meal payments requiring multiple trips from field agents, are known challenges. Pre-paid meters offer significant advantages in this regard. Incentives can also be established to encourage field agents to meet pre-defined collection targets (e.g. 90% collections complete by the 15th of the month). Likewise, small discounts can be granted to customers who pay promptly and in full.

It is critical to have a record-keeping system in place which allows both ESCO personnel and customers to track consumption, billing, and payment. This will help field agents to efficiently target customers with outstanding balances, and minimise disputes by providing verifiable proof of payment. IT-enabled record-keeping can further streamline this process (see Box 4).
Tara Urja’s Customer Management Platform

Tara Urja, in association with Smart Power India, developed a state-of-the-art customer management platform to streamline customer service and resolve issues as they arise. Through this platform, metering, billing, and collection data are uploaded to a central server via a service agent smartphone app, which in turn sends alerts about outstanding bills.

Through the SmartConnect app, customers gain access to their consumption and payment history, and can register complaints or service requests which are automatically directed to the relevant field agents. Site in-charges and ESCO management, meanwhile, are able to remotely track progress on billing and collection, as well as service requests. This gives them a high degree of visibility as to which sites are performing well and which may require intervention.

Since different aspects of mini-grid design are inter-dependent, project design must be an iterative process. Such an inter-dependence is illustrated in Box 5, where the technical configuration of the generating unit, tariffs, consumer affordability, and the level of service provision, all influence one another.

Solar Mini-grids and Supply Timings

Project sustainability demands that customer tariffs reflect the cost of supply. This is especially critical for solar electricity, which is only generated during the day and thus must be stored for night-time consumption. Battery systems provide such storage, but are expensive to buy and place extra operational and management burdens on the plant. It is therefore in plant operators’ interest to incentivise day-time consumption, and ensure that night-time tariffs adequately compensate the greater expense of night-time supply.

Three strategies exist to counter this issue:

1. Commit to supplying electricity only during daytime hours
2. Distribute electricity through multiple feeder lines which supply at different operating hours, and connect customers to the feeder corresponding to their package
3. Use smart meters programmed to adjust tariffs and limit connection based on time of day

Option #1 excludes a majority of consumers; option #2 requires additional spending on the distribution network; option #3 drastically increases capital costs for meters. Option #2 is generally found to strike the best balance between consumer opportunity and the cost of monitoring.

Load Acquisition

Customer demand needs to be maximised within the constraints of generation capacity and service quality. Load acquisition—essentially the ESCO’s sales process—is an ongoing process requiring continuous adjustment to evolving energy requirements, as sketched in Figure 9. (Since package and tariff design has already been covered in Section 4.2, this chapter focusses on the other activities.)
4.3.1 Customer Acquisition

To drive up-take of connections, marketing campaigns are required to sensitize potential consumers about services provided by the mini-grid, and the value addition over current alternatives. Developers should stress the key advantages of mini-grid power mentioned in Section 2.2, while remaining attentive to local energy needs and aspirations.

Different customer categories tend to respond to different marketing strategies:

- **Households**
  - Informational sessions and leaflets in the local mandi
  - Word-of-mouth networks
  - Enabling appliance ownership / increased consumption

- **Shops**
  - Door-to-door visits by sales team
  - Engaging trend-setting pioneer shops
  - Connection fee discounts for conversion

- **Existing commercial businesses**
  - Door-to-door visits by sales team
  - Guarantees of reliability and sufficiency
  - Understanding of electricity as a business input cost

- **Micro-enterprise entrepreneurs**
  - Guarantees of reliability and sufficiency
  - Handholding to develop new businesses

- **Institutional consumers**
  - Guarantees of reliability and sufficiency
  - Approaching head office or regional management team

Initial marketing activities may be supported by an experienced partner, but in the medium to long term ESCOs should develop internal capacity.
There are three broad categories of load acquisition:

1. **Demand conversion**
   Converting users of other sources of energy to become mini-grid customers

2. **Demand enhancement**
   Increasing the consumption of existing customers with new electricity uses

3. **New demand creation**
   Catalysing development of new productive loads to connect to the mini-grid

The acquisition process for these three categories is summarised in the following sections.

### 4.3.2 Demand Conversion

Existing energy users satisfy their energy needs from a variety of sources such as kerosene lamps, standalone solar panels, the DISCOM grid, and diesel generators. The mini-grid’s value addition to such users includes:

- **Improvement in service**
  e.g. replacing a kerosene lamp with more luminous electric lamp

- **Improvement in reliability and quality**
  e.g. providing a steady supply of electricity for the entire day

- **Increasing limit to consume**
  e.g. enabling increased consumption with minimal up-front cost

### 4.3.3 Demand Enhancement

Electricity demand among all consumer types may be constrained due to lack of reliable electricity supply, as well as limited access to affordable electrical appliances. Guaranteed quality mini-grid electricity inclines consumers to increase use of their existing appliances, and invest in new ones.

This trend can be encouraged through appliance access schemes which reduce the cost to the consumer by introducing cheaper alternatives, bulk procurement, and through new financial models like pay-as-you-go and paying in instalments. The ESCO can play a variety of active roles in such schemes, from facilitation, to mediation, to direct execution (see Box 6).
Box 6: Energy Efficient Appliance Schemes

Energy-efficient appliances bring great benefits to those aspiring for improved quality of life but without financial means to pay high electricity bills. They also benefit ESCOs, as more consumers can be served with same generating capacity.

Energy-efficient appliances such as fans, TVs, mixers, and refrigerators have all been successfully marketed to rural mini-grid customers, sometimes directly by the ESCO, and sometimes in partnership with a micro-finance institution. To promote uptake, ESCOs:

- Sold appliances at below-market price, using direct bulk procurement to reduce costs
- Allowed customers to pay in instalments bundled with their electricity bill

Both strategies proved instrumental in the success of appliance schemes.

The table below details some combination energy+appliance packages offered by an ESCO. (These are for illustration only, and details such as hours of electricity supply and profit on appliance sale are omitted.)

<table>
<thead>
<tr>
<th>Appliances</th>
<th>Load limit (W)</th>
<th>Energy tariff (INR / month)</th>
<th>Appliance fee (INR / month)</th>
<th>Instalments (#)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lights + TV</td>
<td>50</td>
<td>250</td>
<td>550</td>
<td>12</td>
</tr>
<tr>
<td>Lights + fan</td>
<td>60</td>
<td>300</td>
<td>500</td>
<td>1</td>
</tr>
<tr>
<td>Lights + TV + fan</td>
<td>90</td>
<td>400</td>
<td>590</td>
<td>12</td>
</tr>
</tbody>
</table>

4.3.4 New Demand Creation

Productive loads range from rural micro-enterprises such as water treatment plants and refrigeration units, to agri-related activities like irrigation pumps, to agri-processing like flour mills. With the exception of irrigation, these high-demand consumers tend to be consistent and reliable, with few affordable energy alternatives available to them.

Absence of certain productive loads in a village might be due to:

1. Lack of reliable power to run necessary equipment
2. Lack of local expertise to develop and manage the business
3. Lack of financial resources to start the business

ESCOs can play a proactive role in identifying potential productive micro-enterprises, addressing the three challenges listed above, and mobilising entrepreneurs. Again, the level of involvement is up to the ESCO: they can advise, facilitate, mediate, or develop and own the enterprise. Each of these approaches have been adopted by ESCOs to add new loads; two examples from a long list of potential enterprise models are illustrated below in Box 7 and Box 8.
Box 7: Water Treatment Units

Rural areas face limited supply of clean drinking water. Growing awareness of the health burden of contaminated water, coupled with demand for chilled water in hot weather, has precipitated the spread of water treatment units in rural areas – especially in places with reliable electricity.

Water treatment units can work well with mini-grids, as they bring a predictable daily demand (typically 20-30 kWh), and a degree of flexibility with timings. ESCOs can play a number of instrumental roles in supplying drinking water in rural areas, including:

1. Identifying opportunity in the village
2. Mobilising an entrepreneur with the necessary business management skills and financial capital
3. Supporting entrepreneurs in sourcing investment (including from the ESCO itself)
4. Building capacity of entrepreneurs to procure equipment and materials, develop their business model, and operate the business

To date, twenty-nine of SPI’s mini-grids have connected new water treatment units. Thirteen of these are operated directly by the ESCO, and the remaining eighteen are deployed by entrepreneurs with support from the ESCO.

Box 8: Oil Expeller Units

Mustard oil is widely used for cooking in northern India. Naturally, mustard oil fetches a higher price than raw mustard seeds direct from the farm; and exporting it to towns and cities is more lucrative than selling in local markets. However, village-level oil extraction tends to be small-scale at best, and so the benefits of value addition are lost to rural communities. Major hurdles to expanding such enterprises include lack of cheap reliable power and downstream market linkages.

Fifteen SPI-supported mini-grids have oil expelling units owned by the ESCO, three of which are operated by self-help groups and the rest by entrepreneurs. Further roles played by the ESCO include:

1. Investing in the units
2. Training operators in the equipment and book-keeping
3. Developing upstream linkages with mustard farmers
4. Developing downstream linkages with outside markets

4.4

Key Considerations

For a project to be truly viable, various risks need to be optimally balanced. The following list illustrates a number of trade-offs to consider.

1. **Optimising capital at risk with other risks** – Capital at risk is the loss to the developer should their project fail: the sunk capital costs. Sometimes, minimising capital at risk will lead to making choices which will increase operational risks or reduce operational efficiencies, leading to unviability of the project. A few examples of such trade-offs
• **Automation** – A fully-automated mini-grid is desirable for reducing operational and manpower costs while maintaining or improving customer satisfaction levels. However, automation may have a limited impact on revenue in the short term, while the extra costs are incurred immediately and may jeopardise the profitability of the project.

The ESCO Tara Urja was aware of this when it started out and avoided automation initially. After over four years of operational experience and business stabilisation, Tara Urja is now investing in development of automated systems for generation, monitoring, and billing.

• **Selecting between biomass and solar** – Choosing biomass over capex-intensive solar reduces the capital at risk. However, biomass developers have historically faced problems in creating robust and low-cost fuel linkages.

To ward off this operational uncertainty, the ESCO Husk Power has developed successful mini-grid models which hybridise biomass and solar generation.

• **Combining solar with a diesel generator** – Aiming to cover 100% of power demand, including transient demand surges, with solar generation alone will lead to significant solar and battery over-capacity and commensurate high costs. These higher capacities remain idle for most of their useful life while increasing the overall risks of the project. Instead, a developer may choose to use a diesel generator to deal with intermittency and demand peaks.

The ESCO OMC makes extensive use of diesel generators to absolutely guarantee reliable supply to their telecom anchor loads while reducing capital expenditures.

2. **Number of consumers and their paying capacity** – A mini-grid developer may seek to recruit as many customers as possible, to raise revenues and stabilise demand. However, pursuit of raw numbers must be balanced against growing administrative costs, for instance in the case of low-demand customers who add little to revenue.

3. **Clustering** – Some operational costs, like technical and management manpower, do not respond linearly with the number of consumers served. ESCOs can make most use of personnel capacity by assigning personnel to serve multiple sites. However, not all locations are suitable for this clustering approach, which limits siting options for ESCOs.
4. **Anchor loads** – Anchor loads guarantee a minimum and steady offtake of electricity, thus reducing the overall risk of the project. However, as noted in Section 2.4, anchor customers also tend to increase the cost to serve and opportunity cost for mini-grid developers. This trade-off is illustrated in Figure 11, which shows that anchor models may increase revenues without much impact on operating margins. Another disadvantage is the restrictions the model places on village selection. However, the benefit is demand reliability and thus risk reduction.

![Figure 11: Illustrative opex break-down of anchor and non-anchor models](image-url)
5

Financing Mini-grids

Identifying instruments and sources for project funding
5.1 Mechanisms and Sources of Finance

Financing used to fund assets and operations plays an important role in project risk and returns. As mini-grid technologies and service delivery models mature, conventional financers are increasingly recognising the opportunities offered by the sector. This chapter enumerates and elaborates the financing instruments which are being successfully used to fund mini-grid projects.

1. Capital Subsidy
   - Central and State Governments have been using capital subsidy to promote mini-grids as a means to provide universal access to electricity.
   - Subsidies by nature need not be returned to the granting agency; however, they typically come with conditions pertaining technical standards, level of services, and consumer tariffs.
   - Governments have recently focussed on expanding DISCOM infrastructure and services, at the expense of mini-grids. This has been demonstrated in the non-renewal of subsidy scheme by the Ministry for New and Renewable Energy (MNRE) and limiting of subsidy to selected villages in Uttar Pradesh and Bihar.
   - Subsidies are announced via Governments’ policies and nodal agencies.

2. Grant
   - Grants are provided by public and private corporate social responsibility (CSR) funds, and foundations (both national and international); see Box 9.
   - Grants have played an important role in project preparation and capital expenditure.
   - They are usually provided by the organisations actively working in the regions under which the selected villages fall.
   - Grants need not be returned, but beneficiary projects and organisations should comply to their requirements like monitoring etc.

Box 9: Grant-Funded Mini-grids

The HCL Foundation, through their Samuday initiative, invested INR 10 crore for developing 20 operational solar mini-grids in Uttar Pradesh.

The Schneider Foundation and Dalmia Foundation have partnered to develop two mini-grids, also in Uttar Pradesh.

*Nodal Agencies are Ministry of New and Renewable Energy (MNRE), Uttar Pradesh New and Renewable Energy Development Agency (UPNEDA), Bihar Renewable Energy Development Agency (BREDA) and Jharkhand Renewable Energy Development Agency (JHREDA) for Government of India, Government of Uttar Pradesh, Government of Bihar and Government of Jharkhand respectively.
3. Debt

- The Indian Renewable Energy Development Agency (IREDA), a Government owned Non-Banking Finance Corporation (NBFC), as well as a number of venture debt funds have provided debt to mini-grids (see Box 10 and Box 11).
- An advantage of debt is that it improves the return on equity for profitable projects.
- A disadvantage of debt is the need for servicing from first year of operations, which exerts pressure on the developers to generate cash quickly.
- Mainstream funding institutions like commercial and rural banks have started recognising renewable energy projects as a priority sector; as such, debt funding is becoming increasingly available.

**Box 10: IREDA Loan Scheme for Mini-grids**

IREDA has a loan scheme to promote access to energy, funded by KfW. Key terms and conditions of the loan scheme are:

- All renewable energy options (except biomass gasifiers) are eligible under the loan facility.
- The project must be implemented in areas where electricity provided through national grid is less than 2 hours during evening (5pm to 11pm).
- For hybrid projects, the conventional energy capacity must be less than the renewable energy capacity.
- The minimum loan amount is INR 50 lakhs.
- The loan can be up to 70% of the total project cost, with the remainder supplied by the promoter.
- The loan tenure is 7 years.
- Applicable interest rates:
  - Loan tenure up to 2 years – 9.75%
  - Loan tenure for 2-4 years – 10.75%
  - Loan tenure over 4 years – 11.50%

In 2019, the ESCO Mlinda received a seven-year loan to develop its mini-grids in Jharkhand.

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3Commercial Banks are mandated to lend to priority sectors identified by Reserve Bank of India. Renewable energy projects are allowed to be funded under priority sector lending.
Box 11: Debt Funding from the Rockefeller Foundation

The Rockefeller Foundation invested US $3 million in cKers Finance, a specialised sustainable energy NBFC that seeks to bring India’s distributed renewable energy businesses to scale. cKers is supported by cKinetics, IIM Ahmedabad’s Centre for Innovation Incubation and Entrepreneurship, Rockefeller Foundation, and Infuse Ventures, amongst others.

cKers provides the entire range of debt solutions for Sustainable Energy companies in emerging segments including:

- Project finance at a micro-scale
- Construction finance
- Working capital
- Venture debt

Independently, the Rockefeller Foundation provided debt of US $3.73 million to the ESCO OMC to build a portfolio of 77 mini-grids. Another tranche of debt funding for US $0.77 million is underway for developing 23 additional mini-grids.

The Rockefeller Foundation also provided debt of US $1 million to the ESCO Husk Power to build a portfolio of 20 mini-grids. Another tranche of debt funding for US $0.5 million is underway for developing 30 additional mini-grids.

4. Equity

- Equity from developers, impact investment funds, development finance institutes or venture capital funds are used most commonly in financing mini-grids (See box 12 for headline examples)
- An advantage of equity is that it reduces short-term risks
- A disadvantage is that it increases pressure on developers and other investors to assume entire risk of mini-grids

Box 12: Major Equity Deals in the Mini-grid Sector


In 2017, OMC Power raised one billion yen from a Japanese conglomerate with interest in energy Mitsui Co. Equity for upgrading existing mini-grids and building new ones.
5.2 Evolving Funding Strategies

Successful mini-grid developers use these financing tools in different combinations at different stages. At the inception stage, developers typically fund their mini-grids with a combination of capital subsidies, grants, and their own equity. Equity allows the developer to expedite the learning process and develop a track record, while subsidies and grants limit the developer’s risk. Once established, developers can approach sources like venture equity funds, venture debt funds, and NBFCs to expand their operations. The debt sourced can potentially be used to re-finance existing successful projects and fund upcoming projects.

Crowd-funding—viz. sourcing small amounts from various individuals or corporations for funding a business or individual project—is now opening up for mini-grids. Grants, equity or debt can be sourced in this way (see Box 13).

**Box 13: Crowd-funding**

Crowdfunding have been used by social projects and businesses serve populations at the bottom of the energy pyramid. For example, the ESCO Mlinda successfully raised funds to develop mini-grids in Jharkhand using the Milaap platform.
6
Policy and Regulatory Landscape
Supporting mini-grid development through government agencies and instruments
6.1 An Enabling Environment for Mini-grids

Recognising the value of mini-grids in rural energy access and livelihoods, The Government of India has taken measures to encourage mini-grid development. Foremost among these are:

1. Permission to operate in rural areas without a license. This gives mini-grids exceptional freedoms to:
   a. Operate alongside DISCOMs
   b. Choose their customers
   c. Choose which services to provide
   d. Design their own tariff structures

2. Framework for interconnection with DISCOM electricity grids. Interconnection enables mini-grids to:
   a. Sell surplus or entire electricity to DISCOMs
   b. Become a distribution franchisee to DISCOMs (in certain states)

These measures allow the mini-grid developers to act as standalone service providers to rural customers. This guarantee of sustained project ownership facilitates investment and growth in the mini-grid space.

To achieve these means, Central and State Governments have used three different tools, namely law, policy and regulation. Distinguishing features of these tools are summarised in Annexure A.

6.2 Central Government Measures

Central Government measures supporting mini-grids include:

1. Delicencing mini-grids – Parliament’s Electricity Act 2003⁴ removed requirements for licences to generate and distribute electricity in rural areas of all states. A corollary of this is to allow mini-grids to operate alongside DISCOMs

2. Interconnection with DISCOM – The Central Electricity Authority (CEA), through Technical Standards for Connectivity of Distributed Generation Resources Regulations, 2013⁵, allows distributed energy sources to be connected to the central grid in all states, and provides guidelines for the interconnection

⁵CEA Regulations (Technical Standards for Connectivity of Distributed Generation Resources Regulations) 2013 and subsequent amendments are available the CEA website http://www.cea.nic.in/connectivityreg.html.
3. Sale of electricity to DISCOM – The Ministry of Power’s Tariff Policy 2016 allows DISCOMs to purchase mini-grid electricity, and provides relevant guidelines. To date a handful of states have adopted these guidelines.

Apart from these measures, the Ministry of New and Renewable Energy, provides different DRE based mini-grids. However, no such subsidy has been available since April 2017.

6.3 State Government Measures

Several states have adopted the Central Government measures in varying forms, and some have further implemented their own policies and regulations. Table 8 lists generic provisions and scope of these two instruments.

| Policy | • Areas for mini-grids to operate  
|        | • Subsidies available and conditions for availing  
|        | • Permitted generation capacities  
|        | • Allowed modes of implementation  
|        | • Support for site selection  
|        | • Tariff to be charged to consumers  
|        | • Specification of nodal implementation agency  
|        | • Operative period of the policy  
| Regulation | • Conditions for interconnection with DISCOMs  
|          | • Technical standards for interconnection  
|          | • Tariff to be charged to consumers  
|          | • Tariff to be charged to DISCOMs |

Measures adopted by Uttar Pradesh and Bihar are summarised in the following sections.

6.3.1 Uttar Pradesh

Uttar Pradesh notified two major instruments: Mini-grid Policy, 2016, and Mini-grid Renewable Energy Generation and Supply Regulations, 2016. These explicitly adopt all Central Government measures, and in addition stipulate subsidy, terms of electricity sale to DISCOMs, and permissions for mini-grids to become distribution franchisees. Measures taken by these agencies include the following (further detail is provided in Annexure B):

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10 Subsidies available from MNRE are updated on their website https://mnre.gov.in.
1. **Operating areas** – Policy and Regulations allow operations of mini-grids in all areas notified by Government as rural.

2. **Interconnection with DISCOM** –
   
   a. Policy and regulations allow mini-grids to be connected with DISCOM.
   
   b. Mini-grids developed in an area with no DISCOM presence can choose to:
      
      i. Operate independently and serve their consumers
      
      ii. Connect to DISCOM and sell surplus electricity
      
      iii. Sell entire electricity generated to DISCOM
      
      iv. Sell assets to DISCOM
   
   c. Mini-grids developed in area with DISCOM presence can choose to:
      
      i. Operate independently and serve their consumers
      
      ii. Sell surplus electricity through the government grid after six months of operations
      
      iii. Sell entire electricity generated to DISCOM after three years of operations
         (The electricity tariff for sale to the DISCOM to be determined by Uttar Pradesh Electricity Regulatory Commission)

3. **Consumer tariff** – Tariff charged by mini-grids to consumers are mutually agreed by the consumers and developers.

4. **Distribution Franchisee** – DISCOMs are allowed to appoint a mini-grid operator as distribution franchisee.

5. **Subsidy** – Uttar Pradesh New & Renewable Energy Development Agency provides capital subsidy (up to 30% of project cost), with guidelines for availing:
   
   a. Subsidised mini-grids can be installed only in villages identified by State Government
   
   b. Mandatory service timings and requirements stipulated
   
   c. Tariff charged to consumers stipulated

   Uttar Pradesh Solar Policy 2017 further provides incentives like exemption of electricity duty, and waiver of stamp duty for solar generating units.

6.3.2 **Bihar**

The Government of Bihar has notified Policy for New and Renewable Energy Sources 2017, with key objectives to provide decentralised renewable energy in rural areas and improve the quality of power supply. The policy adopts all the measures of Central Government, and further specifies the following measures (further detail is provided in Annexure B):

1. **Operating areas** – Developers can deploy mini grids up to a capacity of 500 kW in:
   
   a. Unserved areas (villages or hamlets without grid)
   
   b. Underserved areas (grid areas with low power supply)

---

13Policy for New and Renewable Energy Sources 2017 is available at website of Department of Energy: http://energy.bih.nic.in/
2. **Interconnection with DISCOM** – Policy allows mini-grids to sell power through the DISCOM grid; the mini-grid developer can choose to:

   a. Continue operating in parallel to the DISCOM
   b. Sell surplus electricity to the DISCOM
   c. Transfer the entire project to the DISCOM

3. **Subsidy** – The Government of Bihar shall provide subsidy for mini-grids developed in the priority areas identified by the Government

Regulations allowing DISCOMs to interconnect with mini-grids are yet to be announced by Bihar Electricity Regulatory Commission.

### 6.4 Approvals Required

Developing a mini-grid involves acquiring land for generating station, laying distribution infrastructure, etc. Some of these activities require approvals and clearances, which vary between states.

The following is a list of basic approvals (further elaboration can be found in Annexure C):

1. Land conversion (in case if the site identified is classified as agricultural land)
2. Right of Way to the site and distribution infrastructure
3. No Objection Certificate from the Owner of the Land
4. Consent from Gram Sabha
5. Approval from highway department

This list is not exhaustive. In the absence of official guidelines, ESCOs must coordinate with relevant state authorities, bearing in mind their particular operating model, to gain final project approval.
Business Risks

Identifying and controlling risks to business performance and sustainability
7.1 Challenges, Impacts, and Mitigation Measures

Primarily due to the nature of business spread over multiple remote rural locations, mini-grid projects encounter a unique set of challenges. With appropriate strategies and safeguards in place, these can be minimised or averted altogether. Table 9 presents an overview.

<table>
<thead>
<tr>
<th>Challenge</th>
<th>Impact</th>
<th>Mitigation measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delay in acquiring land and obtaining right of way for</td>
<td>Delay in commencing construction of the project</td>
<td>• Identify more than one potential site for the generating unit&lt;br&gt;• Initiate the land acquisition process as soon as the plant design is finalized&lt;br&gt;• Allow time for land acquisition in project planning&lt;br&gt;• Follow procedures as set by relevant agencies&lt;br&gt;• Engage local government and community for speedy resolution</td>
</tr>
<tr>
<td>distribution lines</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Delay in acquiring permits and approvals</td>
<td>Delay in commencing construction of the project</td>
<td>• Identify requirements for all permits and approvals in advance&lt;br&gt;• Deploy a team for acquiring permits and approvals&lt;br&gt;• Engage authorities providing permits and approvals from the planning stage of the project</td>
</tr>
<tr>
<td>Delay in transportation, limited local manpower, etc.</td>
<td>Delay in project construction</td>
<td>• Carry out thorough assessment on availability of transportation, local resources, etc. during planning&lt;br&gt;• Plan to source labour from outside if local skill levels are insufficient</td>
</tr>
<tr>
<td>Damage of equipment in transportation</td>
<td>• Delay in project construction&lt;br&gt;• Costs of equipment replacement</td>
<td>• Ensure proper packing and loading&lt;br&gt;• Procure suitable transport insurance</td>
</tr>
<tr>
<td>Damage of equipment during construction due to mishandling and accidents</td>
<td>• Delay in project construction&lt;br&gt;• Costs of equipment replacement</td>
<td>• Ensure all safety aspects are considered in the design of the plant&lt;br&gt;• Maintain vigilance of safety conditions on construction site&lt;br&gt;• Procure suitable construction insurance</td>
</tr>
<tr>
<td>Theft at site</td>
<td>• Delay in project construction&lt;br&gt;• Costs of equipment replacement</td>
<td>• Ensure continuous security at site&lt;br&gt;• Procure suitable theft insurance</td>
</tr>
<tr>
<td>Challenge</td>
<td>Impact</td>
<td>Mitigation measures</td>
</tr>
<tr>
<td>------------------------------------------------</td>
<td>-------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Inadequate semi-skilled and skilled manpower</td>
<td>• High cost due to low operational efficiency</td>
<td>• Identify required manpower, skill sets, and their source (both local and outside) during planning stage</td>
</tr>
<tr>
<td></td>
<td>• Lower revenue due to lower generation and customer engagement</td>
<td>• Ensure hiring of manpower well ahead of commencement of operations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Focus hiring on local community, as they are easy to hire, reliable, and bring local knowledge</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Develop a training program to and skill local personnel when required</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Monitor continuously to understand the shortage of manpower and skill</td>
</tr>
<tr>
<td>Improper site selection</td>
<td>• High cost of generation</td>
<td>• Identify several sites and choose the best fit during the project planning stage</td>
</tr>
<tr>
<td></td>
<td>• Lower revenue due to lower generation</td>
<td></td>
</tr>
<tr>
<td>Faulty components</td>
<td>• Frequent plant breakdowns and poor customer experience</td>
<td>• Ensure selection of proper components and their procurement</td>
</tr>
<tr>
<td></td>
<td>• High cost of operations</td>
<td>• Ensure warranty conditions are met</td>
</tr>
<tr>
<td></td>
<td>• Lower revenue due to lower generation</td>
<td>• Monitor continuously and evaluate their actual performance vis-à-vis plant design so as to identify faults early and deploy solutions in time</td>
</tr>
<tr>
<td>On-plant emergencies</td>
<td>• High cost of operations</td>
<td>• Ensure regular training of personnel</td>
</tr>
<tr>
<td></td>
<td>• Lower revenue due to lower generation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Danger to personnel</td>
<td></td>
</tr>
<tr>
<td>Limited demand</td>
<td>• Low plant utilisation</td>
<td>• Demand assessment should be thorough to capture existing demand and future demand</td>
</tr>
<tr>
<td></td>
<td>• Higher tariffs on consumers</td>
<td>• A robust marketing strategy to be designed in the planning phase and implemented during construction and operation phase</td>
</tr>
<tr>
<td></td>
<td>• Low profitability of the project</td>
<td>• Continuous monitoring and adaptation of marketing to local needs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Gradually add generating capacity as demand increases</td>
</tr>
<tr>
<td>Challenge</td>
<td>Impact</td>
<td>Mitigation Measures</td>
</tr>
<tr>
<td>-----------------------------------------------</td>
<td>-----------------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>
| Load intermittency                            | • Sub-optimal plant utilisation  
• Higher tariffs on consumers  
• Low profitability of the project                                                   | • Combine technologies to meet intermittent demand, for example solar and batteries |
| Technical losses in the distribution infrastructure | • Loss of revenue                                                                      | • Choose equipment appropriate to anticipated loads  
• Monitor network efficiency for speedy intervention                                   |
| Theft of electricity                          | • Loss of revenue                                                                       | • Monitor distribution infrastructure for theft through meters and manual inspection  
• Engage community in identifying thefts                                                |
| Accidental damage and theft                   | • Breakdown of operations leading to loss of revenue  
• Higher cost of operations                                                            | • Ensure continuous security presence  
• Procure suitable accident and theft insurance  
• Engage community in preventing and addressing such incidents                           |
| Inability to generate adequate revenue        | • Lower profitability                                                                    | • Design a robust marketing strategy according to local conditions  
• Monitor marketing outcomes for review and improvement                                  |
| Inefficiency and leakage in revenue collection| • Lower revenue realisation                                                              | • Adopt collection strategies such as pre-paid metering, community-based revenue collection, automatic disconnection  
• Train manpower and incentivise them for efficient collection  
• Adopt IT based monitoring solutions                                                    |

**Project risks**

<table>
<thead>
<tr>
<th>Intensification and enhanced penetration of grid supply</th>
<th>• Customer migration to DISCOM</th>
<th>• Select states with guidelines to interconnect mini-grid to main grid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delay in disbursement of subsidy/grant</td>
<td>• Freeze capital of the developer</td>
<td>• Ensure project is financially viable without subsidy/grant</td>
</tr>
</tbody>
</table>
All plant equipment will come with manufacturer warranties, which guarantee repair or replacement if the equipment is found to be faulty or underperforming. Standard warranties can be negotiated to suit the mini-grid developer’s needs: for example, a four-year warranty on a battery bank might be extended to six years if appropriate to mitigate project risks. In particular, on-ground environmental conditions (including temperature, moisture, dust) and operating conditions (variable load and power generation) may put strain on equipment performance and lifetime. Mini-grid developers must pay careful attention to warranty terms and conditions, as these will influence technology selection and plant design.
8

Impact of Mini-grids

Tracking mini-grid outcomes in their local communities
Mini-grids, and the services they deliver, have the potential to be a significant driver of rural development, unlocking latent economic potential and livelihoods, while simultaneously enabling aspirations for improved quality of life.

Existing mini-grid projects have already worked to realise many of these benefits. Specific outcomes include:

- **Increased use of mini-grid as primary electricity source** among all customer segments at different sites, demonstrating the value added by mini-grids to people’s lives

- **Increased access to electrical appliances** for home and business use, promoted by ESCOs’ demand stimulation initiatives and by consumers’ own responses to increased reliability

- **Energy efficiency gains**, both in supply and use, as ESCOs work to drive down technical losses and enable their customers to meet their energy needs affordably

- **Growth in productive loads** from micro-enterprises and commercial establishments, indicating that mini-grids can cause local economies to grow and diversify

- **Incremented incomes**, from direct livelihood creation, from pushing villages up agri-processing value chains, from adding certainty to agricultural yields through irrigation, and from reduction of costs for alternative energy sources

- **Improved health indicators for women and children** from replacement of polluting energy sources such as kerosene lamps, as well as specific health initiatives taken by ESCOs

- **Improved education indicators** through access to reliable household lighting, school power supply, and other information services

- **Reduction of pollution and greenhouse gas emissions**, as renewable energy sources replace fossil fuels

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**Impact of Smart Power India Program**

<table>
<thead>
<tr>
<th>Promotion of Energy-Efficient Devices</th>
<th>Benefits to Women &amp; Children</th>
<th>Safe Drinking Water Initiative</th>
<th>Integrated Irrigation Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>1900+ households</td>
<td>69% women reported reduction in fire accidents</td>
<td>31 Water Treatment Units</td>
<td>840 acres</td>
</tr>
<tr>
<td>Children’s daily study time increased by 2 hours</td>
<td></td>
<td>6,200 lives impacted</td>
<td>47 irrigation pumps</td>
</tr>
</tbody>
</table>

- **GDP + increase in per capita income/year**: $18.5
- **Reduction in Carbon emissions**: 9,415 tons of CO₂/year
- **Electricity consumption by Micro-enterprises**: 0.5 to 2.8 kwh increase
- **Electricity consumption by Households**: 25% increase
- **Promotion of Energy-Efficient Devices**: 1900+ households
- **Benefits to Women & Children**: 69% women reported reduction in fire accidents
- **Safe Drinking Water Initiative**: 31 Water Treatment Units
- **Integrated Irrigation Model**: 840 acres
- **Electricity consumption by Households**: 25% increase

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Mini-grids and their developers have an important role to play in both the delivery and the use of electricity in rural areas. The prominence of mini-grid technologies and business models continues to grow, while the service ecosystem and policy landscape surrounding them is simultaneously maturing. India may well witness a shift in the narrative around last-mile electricity access and delivery. This handbook has endeavoured to provide a first step in facilitating this transition.
Annexure
To make sense of existing frameworks and provisions, it is important to understand the difference between law, policy, and regulations. Key distinguishing features are summarised in Table 10.

<table>
<thead>
<tr>
<th></th>
<th>Law</th>
<th>Policy</th>
<th>Regulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Authority</td>
<td>Legislature</td>
<td>Ministry / Department</td>
<td>Electricity Regulatory Commission</td>
</tr>
<tr>
<td>Stakeholders</td>
<td>Multiple</td>
<td>Multiple</td>
<td>DISCOMs</td>
</tr>
<tr>
<td>Scope</td>
<td>Broad scope, with focus on</td>
<td>Broad scope, with focus on</td>
<td>Covers aspects like grid interconnectivity</td>
</tr>
<tr>
<td></td>
<td>responsibilities of all stakeholders</td>
<td>facilitation mechanisms</td>
<td>and feed-in tariffs</td>
</tr>
<tr>
<td>Nature</td>
<td>Binding on all stakeholders</td>
<td>Binding on Issuing Authority; non-</td>
<td>Binding on DISCOMs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>binding on others</td>
<td></td>
</tr>
</tbody>
</table>
### Summary of Uttar Pradesh Mini Grid Policy 2016

<table>
<thead>
<tr>
<th>Nodal Agency</th>
<th>Uttar Pradesh New &amp; Renewable Energy Development Agency (UPNEDA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area of Operations</td>
<td>Un-electrified habitations/hamlets and in contiguous undeveloped and backward rural/urban areas deprived of conventional grid or with relatively lesser supply of electricity</td>
</tr>
<tr>
<td>Operative period</td>
<td>10 years from notification i.e., until 2026</td>
</tr>
<tr>
<td>Project Capacity</td>
<td>Not more than 500 kW</td>
</tr>
</tbody>
</table>
| Subsidy and guidelines for availing | • Up to 30% of the project cost  
• Project shall be installed in villages/Majras identified by UPNEDA/State Govt  
• Projects shall operate under Build Own Operate and Maintain (BOOM) model  
• Developers shall be selected by UPNEDA through bidding process based on viability gap funding (VGF)  
• Land to be arranged by the developers  
• Mandatory daily supply of 3 hours in the morning and 5 hours in the evening for domestic loads  
• Daily 6 hours supply of electricity for other production and commercial needs  
• Tariff  
  o Rs. 60/- per month for load of 50 Watt  
  o Rs. 120/- per month for load up to 100 Watt  
  o Mutually agreed tariff for load beyond 100 Watt  
• Systems should comply with guidelines of CEA and Uttar Pradesh Power Corporation Ltd |
| Guidelines for non-subsidised projects | Guidelines for subsidised projects do not apply to projects not seeking subsidy, i.e. developers are free to select the villages, determine their own tariffs and supply hours are not mandatory |
Summary of UPERC Mini-Grid Renewable Energy Generation and Supply Regulations, 2016 is found in Table 12.

<table>
<thead>
<tr>
<th>Allowed project size</th>
<th>Up to 500 kW</th>
</tr>
</thead>
</table>
| Allowed areas        | • Rural areas  
• Areas having inadequate supply of electricity during peak hours and/or compulsory supply hours  
• Mini-grids are allowed to be developed in areas with and without grid presence |
| Interconnection with grid when expands | • Mini-grids are allowed to interconnect with DISCOM when extended to the mini-grid area of operations  
• Interconnection shall comply with CEA guidelines  
• Any cost of interconnection shall be borne by the mini-grid operator  
• Mini-grids can choose to  
  o Operate independently and serve their consumers  
  o Connect to DISCOM and sell surplus electricity  
  o Sell entire electricity generated to DISCOM  
  o Sell assets to DISCOM |
| Interconnection with existing grid | • Mini-grids are allowed to operate in areas with existing DISCOM services  
• Interconnection shall comply with CEA guidelines  
• Any cost of interconnection shall be borne by the mini-grid operator  
• Mini-grids can choose to  
  o Operate independently and serve their consumers  
  o Connect to DISCOM and sell surplus electricity after six months of operations  
  o Sell entire electricity generated to DISCOM after three years of operations |
| Applicable Tariff on electricity sold to DISCOM | • Tariff is determined by UPERC  
• Currently tariffs determined in UPERC Captive and Renewable Energy Generating Plants) Regulations, 2014 are applicable |
| Applicable Tariff on electricity sold to consumers | • Tariffs mutually agreed by consumers and mini-grid operators  
• For subsidised projects, tariff shall be as per the UP Mini-grid Policy 2016 |

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Table 12: UPERC Mini-Grid Renewable Energy Generation and Supply Regulations, 2016

14Tariffs notified in the said regulations are valid for projects commissioned until March 2019.
Summary of Bihar Policy for New and Renewable Energy Sources 2017 can be found in Table 13.

### Table 13: Bihar Policy for New and Renewable Energy Sources 2017

<table>
<thead>
<tr>
<th>Nodal Agency</th>
<th>Bihar Renewable Energy Development Agency (BREDA)</th>
</tr>
</thead>
</table>
| Area of Operations                 | • Unserved areas (villages or hamlets without grid supply)  
                                         • Underserved areas (grid areas with low power supply) |
| Operative period                   | 5 years from notification, i.e. until 2021         |
| Project Capacity                   | Not more than 500 kW                               |
| Subsidy and guidelines for availing | • Subsidy is available as per the policy but the quantum is not defined.  
                                         • Project shall be installed in the priority areas identified by BREDA  
                                         • Projects shall operate under Build Own Operate and Maintain (BOOM) model |
| Guidelines for non-subsidised projects | Guidelines for subsidised projects do not apply to projects not seeking subsidy, i.e. developers are free to select the villages for operations |
C. Approvals and Clearances

<table>
<thead>
<tr>
<th>Approval</th>
<th>Documents required</th>
<th>Approval timeline</th>
<th>Agency</th>
</tr>
</thead>
</table>
| Land clearance (in case existing land is agricultural land) | • Sale/lease deed  
• Project layout plan  
• Request Letter for Land Use / Land Conversion as per prescribed formats | At the time of submission of Intimation Letter to initiate construction | District Magistrate Office    |
| Right of Way                                      | • Project layout plan  
• Site map approved by registered civil engineer | Prior to initiating project construction               | District Magistrate Office    |
| Fire No Objection                                 | • Four sets of project drawings including the site plan, key plan, floor layout, elevation plan  
• Fire Project Report | Prior to initiating project construction               | Fire Service Department       |
| Electrical Safety Inspection                      | • Electrical plan layout                                                          | During project construction                           | Electrical Safety Department  |

Box 15: Waiver of Approvals and Clearances

Central and State Governments may revise the approvals and clearances required for mini-grids. These revisions are usually a part of the mini-grid policy, but may also feature in other related policies involving mini-grids: for example, renewable energy policy and industrial policy.

Uttar Pradesh New & Renewable Energy Development Agency (UPNEDA) through the Government Order in reference to Solar Energy Policy 2017 exempted mini-grid developers from acquiring the following approvals for developing mini-grids in Uttar Pradesh:

- Stamp duty exemption
  - Circular No. 03/2018/87/94-St.N.2-2018/700(476)/2017
- Exemption from Inspection by Electrical Inspector
  - Circular No. 273/24-P-3-2018-SA(10)/2018
- Electricity Duty exemption
  - Circular No. 272/24-P-3-2018-SA(10)/2018
- Environmental Clearance exemption
  - Circular No. 6/2018/251/5-1099/1/2018
- Exemption from consent/No objection certificate from U.P. Pollution Control Board
  - Circular No. 6/2018/251/5-1099/1/2018
- Exemption from permission for construction of structure on roofs
  - Circular No. 303/87/2018
Mini-grid activities overlap a number of sectors – electricity access, renewable energy, and a variety of rural and social issues. Accordingly, funding bodies and agencies which focus on any of these sectors may be relevant for mini-grid developers.

The following is an indicative list of agencies which have supported these sectors in the past.

<table>
<thead>
<tr>
<th>Funding Agencies</th>
<th>Equity Fund</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Aavishkaar</td>
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<td></td>
<td>Acumen</td>
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<td></td>
<td>Gray Ghost Ventures</td>
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<tr>
<td></td>
<td>ABN Amro Bank Social Impact Fund</td>
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<td></td>
<td>Encourage Capital</td>
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<td>Actis</td>
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<td>Eivar Equity</td>
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<tr>
<td></td>
<td>Infuse Ventures</td>
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<td></td>
<td>Insitor Fund</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Bilateral and Multilateral Agencies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asian Development Bank (ADB)</td>
</tr>
<tr>
<td>Agence Française de Développement (AFD), France</td>
</tr>
<tr>
<td>Department for International Development (DFID), U.K.</td>
</tr>
<tr>
<td>International Finance Corporation (IFC)</td>
</tr>
<tr>
<td>United Nations Development Program (UNDP)</td>
</tr>
<tr>
<td>Japan International Cooperation Agency (JICA), Japan</td>
</tr>
<tr>
<td>KfW, Germany</td>
</tr>
<tr>
<td>Nordic Investment Bank (NIB)</td>
</tr>
<tr>
<td>Norwegian Agency for Development Cooperation (Norad)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Large NBFC</th>
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</thead>
<tbody>
<tr>
<td>India Renewable Energy Development Agency</td>
</tr>
<tr>
<td>PFC-Green Energy</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Global Foundation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aga Khan Foundation</td>
</tr>
<tr>
<td>Calvert Foundation</td>
</tr>
<tr>
<td>Citi Foundation</td>
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<tr>
<td>Climate Works Foundation</td>
</tr>
<tr>
<td>Rockefeller Foundation</td>
</tr>
<tr>
<td>Hewlett Foundation</td>
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<tr>
<td>Khemka Foundation</td>
</tr>
<tr>
<td>Lemelson Foundation</td>
</tr>
<tr>
<td>Rockefeller Brothers Fund</td>
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<tr>
<td>Shell Foundation</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Climate Fund</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global Climate Fund</td>
</tr>
<tr>
<td>Global Environment Fund</td>
</tr>
</tbody>
</table>
### Angel Investors/Angel Networks

<table>
<thead>
<tr>
<th>Artha Platform</th>
<th>Indian Angel Network</th>
</tr>
</thead>
<tbody>
<tr>
<td>I3N</td>
<td>Mumbai Angels</td>
</tr>
<tr>
<td>TiE Entrepreneurship Acceleration Program</td>
<td></td>
</tr>
</tbody>
</table>

### Crowd funding Platforms

<table>
<thead>
<tr>
<th>Milaap</th>
<th>Faircent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wishberry</td>
<td>Catapooolt</td>
</tr>
<tr>
<td>Ketto</td>
<td>Impact Guru</td>
</tr>
<tr>
<td>BitGiving</td>
<td>Fuel A Dream</td>
</tr>
<tr>
<td>Crowdera</td>
<td>MicroGraam</td>
</tr>
</tbody>
</table>
# Glossary

## Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>CEA</td>
<td>Central Electricity Authority</td>
</tr>
<tr>
<td>CSR</td>
<td>Corporate Social Responsibility</td>
</tr>
<tr>
<td>DISCOMs</td>
<td>Power Distribution Companies</td>
</tr>
<tr>
<td>DRE</td>
<td>Distributed Renewable Energy</td>
</tr>
<tr>
<td>ESCO</td>
<td>Energy Service Company</td>
</tr>
<tr>
<td>INR</td>
<td>Indian Rupee</td>
</tr>
<tr>
<td>IREDA</td>
<td>Indian Renewable Energy Development Agency</td>
</tr>
<tr>
<td>JP ¥</td>
<td>Japanese Yen</td>
</tr>
<tr>
<td>km</td>
<td>kilometer</td>
</tr>
<tr>
<td>kW</td>
<td>kilowatt</td>
</tr>
<tr>
<td>kWh</td>
<td>kilowatt-hour</td>
</tr>
<tr>
<td>kWp</td>
<td>kilowatt peak</td>
</tr>
<tr>
<td>MNRE</td>
<td>Ministry of New and Renewable Energy</td>
</tr>
<tr>
<td>NBFC</td>
<td>Non-Banking Finance Corporation</td>
</tr>
<tr>
<td>TV</td>
<td>Television set</td>
</tr>
<tr>
<td>US $</td>
<td>US Dollar</td>
</tr>
<tr>
<td>W</td>
<td>Watt</td>
</tr>
</tbody>
</table>

## Acronyms

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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</thead>
<tbody>
<tr>
<td>Alternative energy sources</td>
<td>Sources from which consumers meet their energy demand apart from DISCOM grid and DRE-based mini-grids. Includes kerosene lamps, solar home systems, diesel generators, batteries + inverters, etc.</td>
</tr>
<tr>
<td>Consumer</td>
<td>A person, household, commercial establishment, etc. with a demand for electricity.</td>
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<tr>
<td>Consumption</td>
<td>Energy used by a consumer over a period of time, in kWh or “units”.</td>
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<tr>
<td>Customer</td>
<td>Client of an ESCO – a subset of consumers.</td>
</tr>
<tr>
<td>Distribution franchisee</td>
<td>Private agent to whom rights are granted to manage electricity distribution on behalf of DISCOM</td>
</tr>
<tr>
<td>Electric grid</td>
<td>A network of transmission and distribution lines through which consumers are connected to centralised power generation sources.</td>
</tr>
<tr>
<td>ESCO</td>
<td>An Energy Service Company that provides electricity to consumers.</td>
</tr>
<tr>
<td>Load</td>
<td>A device or collection of devices that need electricity to operate. Also, the power, measured in W or kW, that is required to run these devices.</td>
</tr>
<tr>
<td>Micro-grid</td>
<td>System having a generator with capacity of below 10 kW and supplying electricity to target set of consumers through a distribution network.</td>
</tr>
<tr>
<td>Mini-grid</td>
<td>Similar to micro-grid but having a generation capacity greater than 10 kW; in this hand-book mini-grids are assumed to be based on renewable energy.</td>
</tr>
<tr>
<td>Distribution company</td>
<td>Companies appointed by Government to supply electricity to consumers within a geographical area, through the electric grid.</td>
</tr>
</tbody>
</table>
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