Utilising Electricity Access for Poverty Reduction

ANNEX 3 - CASE STUDY REPORT: INDIA

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Executive Summary

The research presented in this report forms one of two Case Studies prepared for the project Utilising Electricity Access for Poverty Reduction. The Case Study seeks to answer, in the Indian context, the questions:

1. **What level of electricity access is required to enable and sustain poverty escape?**

2. **What constraints, despite increased access to electricity, mean that people are not able to use that electricity productively?**

The research has been carried out through desk studies of policy and regulation, consultations with stakeholders involved in electricity provision and field research focusing on communities touched by four different electricity access programmes.

Overall, the field research has not revealed a consistent relationship between levels of electricity access and its impacts in terms of either productive activity or poverty reduction. Enterprises with electricity access seemed to enjoy increases in profits greater than those without electricity access, but their revenues (and changes in their revenues) were roughly the same. Beneficiary households had higher incomes and saw greater increases in household income, but the difference is not large enough to be conclusive. Electricity access seems to have offered considerable benefits for education, and to a lesser degree healthcare. Employment was higher amongst non-beneficiaries, while increases in employment amongst both beneficiaries and non-beneficiaries appeared to go to men and not women.

When viewed on a case-by-case basis some of the programme studies offer more compelling evidence of the positive impacts of electricity access, at least in contexts of communities where there is an obvious deficiency in basic energy services (lighting), suffered by almost all households and enterprises, that the electricity access programme can address.

The solar lantern programme covered by Case Study P3 (the Lighting a Billion Lives programme in Orissa) appears to have conferred substantial benefits to the customers of the solar lantern rental service, despite providing electricity access that only registers as a small step on the scale. With strong evidence of relationships between electricity access and enterprise profits, enterprise revenues, household income and quality of education, in many ways the LaBL case study showcases the potential for even very basic electricity access programmes to catalyse economic activity, and/or to be taken full advantage of in the wake of increasing economic activity. However, the success of this programme in the location studied is also dependent on the presence of a number of enabling factors, without which the positive impact would be much lessened or non-existent. The absence of these same factors, or opposing constraining factors, may go some way towards explaining the weaker impact of some of the other programmes studied, despite the broader electricity services they offer and enable.

Numerous policy factors were identified that influence the provision of electricity access, which enjoys strong political support and mobilisation but does not achieve its potential because of the confusing multiplicity of electrification and electricity access programmes in India. Subsidy support for rural electrification projects is helpful, but could be better targeted to assist developers to cover high ongoing costs of provision. Rural off-grid provision is enabled by relaxed licensing and tariff-setting rules but constrained by lack of cross-subsidy (compared to grid electricity) and opaque grid extension plans.

The take up of available electricity access through Solar Home Systems is encouraged by a subsidy of 40%, although meeting the remaining cost is still a challenge for credit-starved households and enterprises. The high cost of off-grid electricity means that productive users of off-grid access may struggle to compete with users of subsidised grid electricity. In general, electricity access programmes do not give sufficient attention to productive uses of electricity.

In the communities studied, the assessed level of electricity access for households appears to be driven almost entirely by capacity and affordability, whereas capacity and availability are the key limiting attributes for enterprises' electricity access. However, the participants in focus groups held in each community pair also identified poor quality and reliability as constraints on their household and productive use of power, a sentiment that was closely echoed by the views of the electricity access provider stakeholders consulted. Quality, reliability and availability were also among the top five most widely reported enabling factors/constraints by the households and enterprises surveyed. Costs appeared to be of much more concern to households than to enterprises, which matches expectations given that typically energy costs make up a much smaller proportion of the cash flow of an enterprise.

Interviewed stakeholders felt that skills requirements and lack of access to markets for products and services are among the most severe barriers to the successful uptake of new productive activities following an increase in electricity access. Economic activity cannot normally be promoted through electricity alone; rather, it is by putting village-scale productive uses at the heart of electricity access provision that policymakers and programme developers can simultaneously improve the viability of electricity access projects and better ensure that the ultimate aims of poverty reduction and economic development are achieved.

Acronyms

BOP	Bottom of Pyramid
BPL	Below Poverty Line
CEA	Central Electricity Authority
CGMSE	Credit Guarantee Scheme for Micro and Small Enterprises
DDG	Decentralised Distributed Generation
DISCOM	Distribution Company
EA 2003	Electricity Act 2003
ESMAP	Energy Sector Management Assistance Programme
HPS	Husk Power Systems
ICT	Information and Communications Technology
IDES	Integrated Domestic Energy Systems
IEA	International Energy Agency
IFC	International Finance Corporation
IFMR	The Institute for Financial Management and Research
INR	Indian Rupee
IREDA	Indian Renewable Energy Development Agency
GTF	Global Tracking Framework
HH	Household
JLG	Joint Liability Group
JNNSM	Jawaharlal Nehru National Solar Mission
kW , kWh	kilo Watt , kilo Watt hour
LaBL	Lighting a Billion Lives
MNES	Ministry of Non-conventional Energy Sources
MNRE	Ministry of New and Renewable Energy
MoP	Ministry of Power

MW, MWh	mega Watt, mega Watt hour
NABARD	National Bank for Agriculture and Rural Development
NEP	National Electricity Policy
NRLM	National Rural Livelihood Mission
NTP	National Tariff Policy
PAC	Practical Action Consulting
REC	Rural Electrification Corporation
REDB	Rural Electrification Distribution Backbone
REP	Rural Electrification Policy
REST	Rural Electricity Supply Technology
RGGVY	Rajiv Gandhi Grameen Vidyutikaran Yojana
RISE	Readiness for Investment in Sustainable Energy
RVEP	Remote Village Electrification Programme
SCS	Solar Charging Station
SE4ALL	Sustainable Energy For All
SERC	State Electricity Regulatory Commission
SHG	Self Help Group
SHS	Solar Home System
SME	Small and Medium Enterprises
TERI	The Energy and Resources Institute
VEC	Village Electricity Committee
VESP	Village Energy Security Programme
VLE	Village Level Enterprise
W , Wh	Watt , Watt hour

Contents

Introduction

This document is one of a pair of Case Study Reports prepared to communicate the findings of the in-country research carried out in India and Kenya respectively as part of the DfID-funded study on Utilising Electricity Access for Poverty Reduction.

This research has been carried out to elaborate and confirm the conclusions derived from the literature review regarding the relationship between levels of electricity access provided and poverty impacts and to further explore constraints on take-up and utilisation of available electricity access for productive purposes. The research has also examined:

- What regulatory and policy measures will be most critical in increasing use of electricity access for productive purposes by poor people?
- How can programmes for electricity access best be designed to incorporate measures which will allow constraints on productive uses to be overcome?
- What technologies and on and off grid electricity systems can provide the levels of electricity access needed for productive use while achieving the greatest value for money?

This Case Study Report begins with a review of India's electricity access regulatory and policy frameworks (Section 1).

In order to explore further how this regulatory/policy framework affects the implementation and success of electricity access programmes in India, a consultation of electricity access provision stakeholders was conducted. The consultation also explored some of the technical, economic and socio-cultural constraints behind implementing and operating such projects, and considered factors affecting the take-up and productive use of available electricity access. The results of the consultation are outlined in Section 2.

The third section of this report describes the results of the field research, which involved the gathering of primary data from communities that had and had not benefitted from four different electricity access programmes: national grid extension, two mini-grid programmes (Husk Power Systems and Mlinda Foundation) and a solar lantern programme (Lighting a Billion Lives).

Section 3 begins by outlining the methodology by which the four sets of survey data and supporting information were analysed. Each programme case study is then described with discussion of its design and focus, costs, scale, impacts, constraining/facilitating factors identified as having been present, and feedback from the group discussions held with community stakeholders:

Finally each of the programme case studies concludes with an analysis of the field survey data and the relationships between:

– The level of access made available and any increase in productive activity
– The increase in productive activity and the scale of poverty impact
– The level of access made available and the scale of poverty impact

The report then looks across the programmes, the policy/regulatory review and the stakeholder discussions at the factors influencing households and enterprises in their decisions as to whether to take up electricity access (Section 4) and at the costs of providing electricity relative to the level of access provided (Section 5).

Section 6 brings together the findings from all the components of the case study research and presents conclusions and recommendations.

1. Review of Electricity Access Regulatory/Policy Framework

1.1. India's electricity sector

'Electricity' is a concurrent subject in the constitution of India, implying that both the Parliament and the State Legislature have been empowered to make laws on the subject. The Constitution has, however, given supremacy to Central Legislation, meaning thereby that if there is a direct conflict or inconsistency between a Central Act and the provisions of a State Legislation, then the law made by the Parliament shall prevail and the inconsistent provisions of the State Legislation shall be void.

The government made conscious efforts since the beginning of planned economic development in the country in 1951 to make substantial improvements to the electricity infrastructure in terms of availability and accessibility. As a result, the power supply industry has grown considerably in terms of (a) installed electricity generating capacity, (b) per capita electricity consumption, and (c) village electrification. The installed capacity has grown manifold from 1362 MW in 1947 to more than 250 GW as on July 31, 2014 (Central Electricity Authority, 2014).

Similarly, the rural electrification level and per capita consumption level has also increased considerably in terms of coverage from 1500 villages and 14 kWh in 1947 to about more than half a million villages and little less than 1000 kWh respectively in 2013 (Figure 1 and Figure 2). In spite of this progress, 306 million Indians were living without electricity in 2011 (IEA 2013). While most villages - around 95.6% of the total 597,464 villages - have electricity access through centralised grid (CEA, 2014), renewable energy technologies such as solar PV, biomass gasifier and mini/micro hydro have also been disseminated in areas which are either inaccessible for grid connectivity or in hamlets that are not recognised as a village as per the national census record. However, the household electrification rate is much lower at about 67%. In absolute terms, almost 77 million households in India were living without electricity in the year 2011 (Figure 3) (Census of India, 2011).

Only nine out of the 29 states in India have achieved more than 90% household electrification with larger states such as Assam, Bihar, Madhya Pradesh, Rajasthan, Uttar Pradesh and West Bengal lagging behind in terms of their rural electrification efforts. Specifically, the states of Uttar Pradesh (with 20 million households), Bihar (with 15 million households) and West Bengal (9 million households) accounts for more than 50% of the non-electrified households. The low household electrification level in many states reflect the fact that historically the level of electrification has been measured as a percentage of electrified villages (and not as a percentage of electrified households) with grid extension to any point within the revenue boundary of a village, irrespective of whether any household is getting connected or not. Interestingly, the initial focus of electrification was to energise agricultural pump sets to improve agricultural productivity as part of the green revolution. Initiatives to enhance household electrification were first given emphasis during late eighties (please refer subsequent sections for details). The official "definition" of village electrification has also evolved over the years and is a significant factor in understanding electrification efforts in India (Figure 4). Since 2004, the Government of India adopted more comprehensive definition of village electrification[1]. As a result many villages that were previously considered electrified was classified as un-electrified category with almost 10% drop in 2004-2005 in village electrification rate (Figure 1). Energy poverty in India is further exacerbated by the lack of an integrated policy framework, division of the energy sector across multiple agencies, overemphasis on serving urban customers, misdirected subsidy regimes, ineffective implementation, poor governance of the sector, resource constraints and other structural factors (Balachandra 2011; Krishnaswamy 2010; Kemmler, 2007).

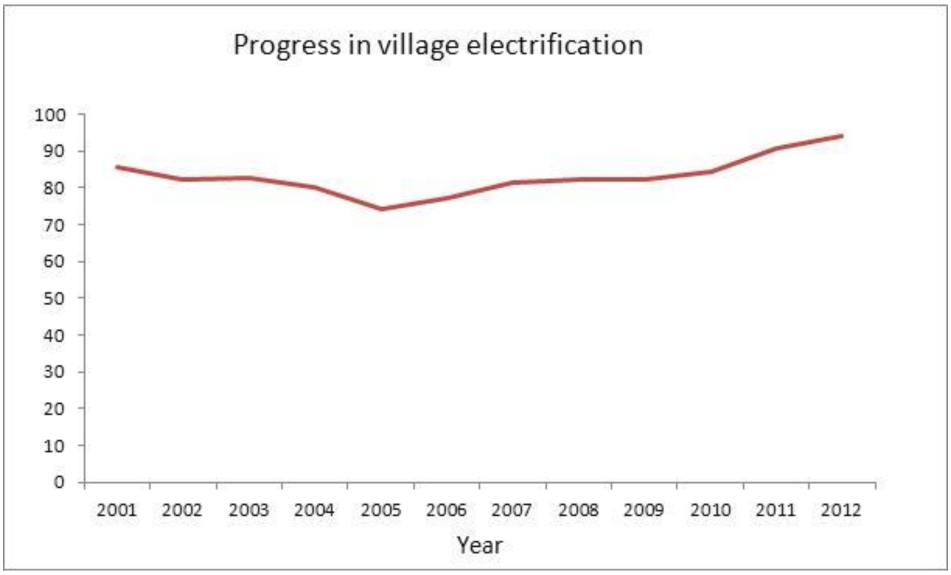

Figure 1: Trend (in percentage) of electrification in India (Source: Prayas, 2011)

[1] A village will be deemed to be electrified if: basic infrastructure such as distribution transformer and distribution lines are provided in the inhabited locality as well as the hamlet where it exists; electricity is provided to public places like schools, panchayat office, health centers, dispensaries, community centers etc. and the number of households electrified should be at least 10% of the total number of households in the village.

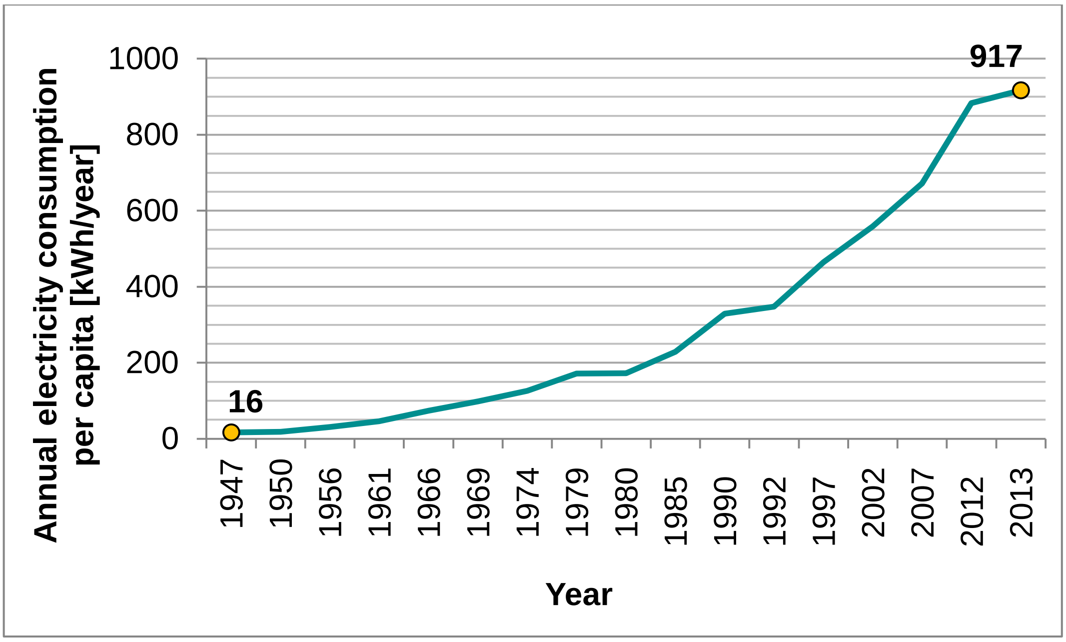

Figure 2: Per Capita Electricity Consumption in India (CEA, 2013)

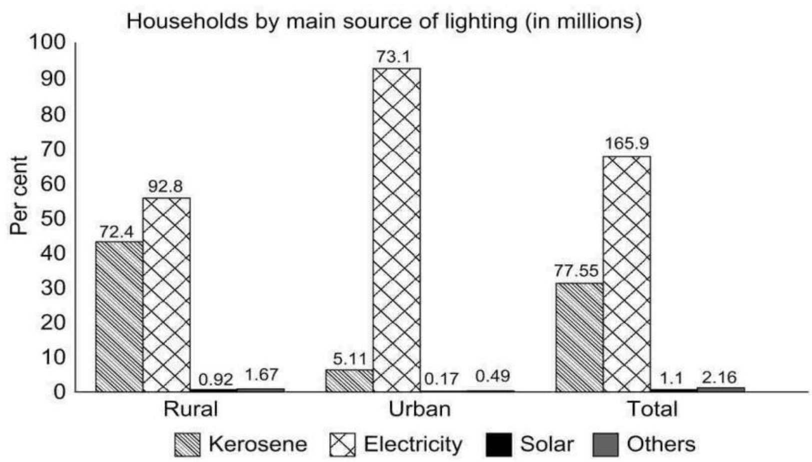

Figure 3: Electricity access in India (Source: Census of India, 2011)

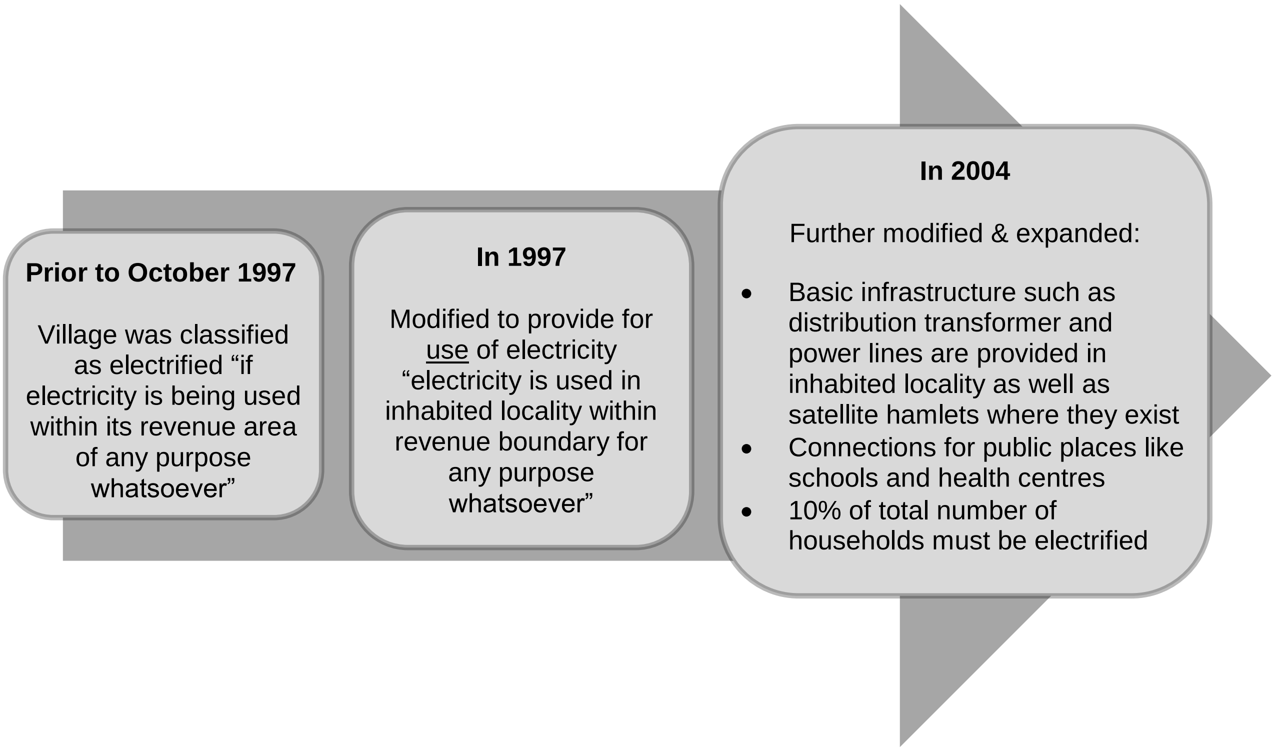

Figure 4: Evolving definitions of village electrification

Being the third largest economy in the World, the demand for electricity, including losses during transmission and distribution, has been outpacing the supply. The Economist Intelligence Unit (2014) claims that 11 percent of electricity capacity is lost from coal (which is used for around 57 percent of total generation) supply shortages, equipment failures, and transmission losses. These losses average 25 percent across the country reflecting a high level of inefficiency, technical losses, low levels of investment, and electricity theft. Non-technical losses such as electricity theft and low billing and collection efficiency also present a challenge for state distribution utilities. In addition, India's electricity sector is one of the most subsidised in the world. Approximately 1.5 percent of India's GDP is spent in subsidising electricity, which is often provided below the cost of production (Swain and Chamoz 2012). The largest share of subsidy expenditure is spent in the agricultural sector, which consumes a quarter of the total electricity produced. These issues strain fiscal spending for the federal government, limit cost recovery for utilities, and lower incentives for private sector investment in infrastructure.

There is also a geographic and income-based divide in terms of electricity access. Urban areas or upper-income households consume more electricity than do rural areas or lower-income households (Ramji et al., 2012). Even among urban and rural households with comparable incomes, the former consume more electricity. Generally, however, electricity consumption per capita increases with higher levels of income (Ramji et al, 2012). As Figure 5 indicates, there is a clear link between economic development of a state and its electrification rate. States with low per capita income have performed poorly compared to those with higher income. Further, low-income groups appear to use electricity mostly for lighting, whereas elevated electricity consumption among upper-income groups can be attributed to appliances and productive use. This may be because a majority of programmes of the central and state governments in India for rural household electrification have focused only on connecting the below poverty line (BPL) households and providing them single lighting point and not on electricity for productive usage (except for irrigation pumping).

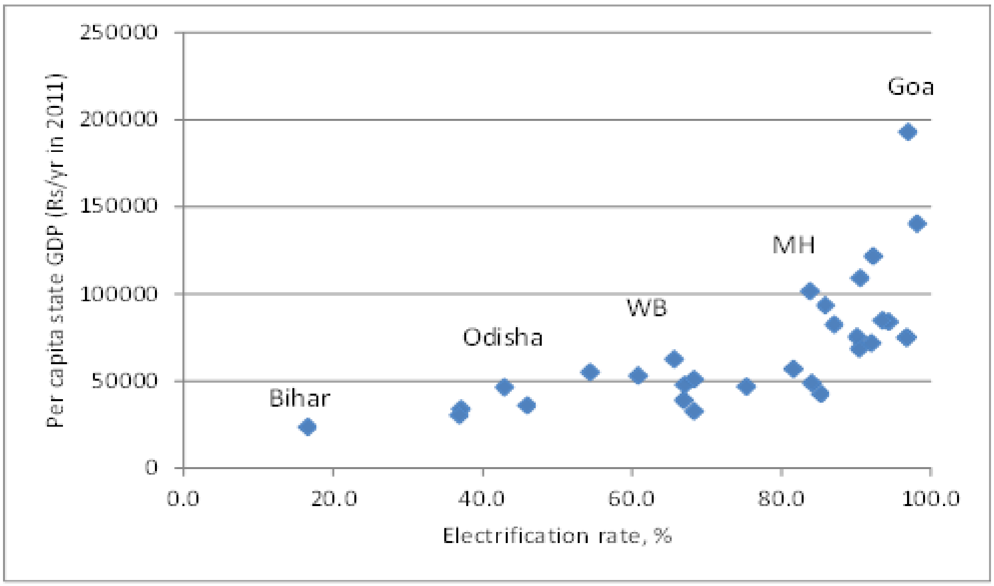

Figure 5: Electrification improves with per capita income
(Source: Census 2011 & Economic Survey 2012-13)

1.2. Electricity access-specific policy and regulation

The provisions for enhancing electricity access are embodied in various provisions of the Electricity Act 2003 (EA 2003), the National Electricity Policy framed under the EA 2003, Rural Electrification Policy 2006 and the National Tariff Policy framed under the EA 2003. The following section provides the summary of the relevant policies for enhancing electricity access in India.

1.2.1. The Electricity Act 2003

The EA 2003 was enacted in June 2003 with the overall objective of developing the electricity industry and providing electricity access to all areas. The Act envisaged a two pronged approach for improving rural electricity access: a national policy for rural electrification to extend the reach of grid-connected supply together with enlistment of local initiatives in bulk purchase and distribution of electricity in rural areas, and a national electricity policy to encourage additional capacity addition by way of stand-alone systems including those based on renewable sources of energy. A host of reforms and policy measures are contained in the Act, namely:

- de-licensed generation and distribution in rural areas notified by the state governments;

- increased freedom for captive generation;
- recognition of trading as an independent activity;
- introduction of open access in transmission and distribution in a phased manner; and
- approval of multiple licensees in distribution.

Under Section 5, the Act mandates the Central Government to formulate policy for rural electrification empowering local governance institutions and local community regarding the purchase of power and management of distribution in rural areas. In order to make rural electrification effective, the Act mentions that there will be focus on decentralised distribution of electricity involving local governance institutions, users' associations, cooperative societies, non-governmental organisations and franchisees.

Under Section 6, the Act obliges the government (both state and central) to supply electricity to rural areas including villages and hamlets. Under section 2(63), it also specifies distributed generation through mini-grid and stand-alone energy systems as a mode for rural electrification in addition to grid extension.

Section 13 (read with Section 5) of the Act states that the central or state Regulatory Commission, on recommendation by the central or state government, shall exempt local authority, local governance institutions, users' associations, cooperative societies, non-governmental organisations and franchisees from the requirement to obtain a licence from the Commission for the distribution of electricity in rural areas.

Section 14 provides the framework for generation and distribution of electricity in rural areas. The eighth proviso Section 14 (read with Section 4 of the Act) provides that a person undertaking generation, based on renewable energy or non-conventional energy sources, and distribution of electricity in a rural area, specified by the State Government, shall not require any licence (Figure 6). However, the measures specified by the Central Electricity Authority may apply.

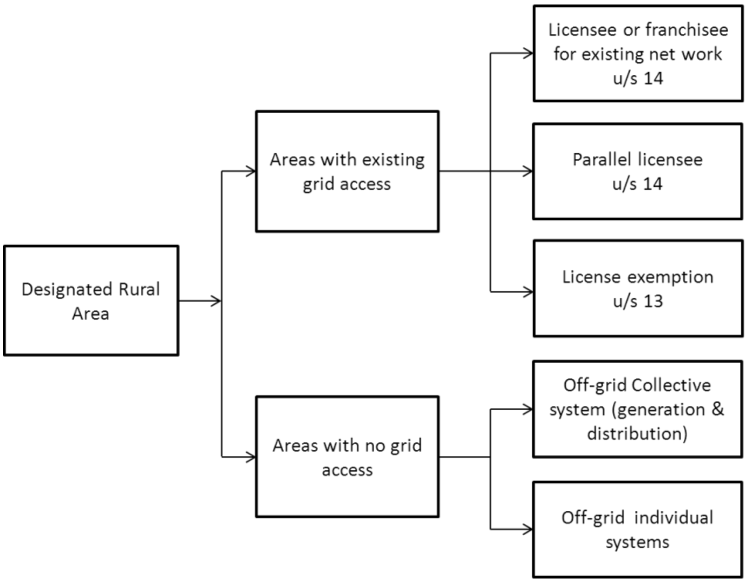

Figure 6: Electrification options in rural areas

The EA 2003 also laid out provisions to enable the development of a competitive electricity market for generation, transmission and distribution. Significantly, the Act made generation a non-licensed activity; essentially, any entity, public or private, could set up a generation plant subject to environmental clearances, except for hydro-electric plants above a certain amount of capital investment. In addition, generators were allowed to sell electricity to any distribution licensee, and, where permitted by State Electricity Regulatory Commission (SERCs), even directly to consumers. The setting up of captive power plants was de-licensed and the process made easier. Furthermore, the definition of "captive generation" was extended beyond industrial users to include "plants set up by a cooperative society or an association of persons primarily for the members of that society or association". Captive producers were permitted under the Act to feed or sell excess power to the grid, with SERCs tasked with determining the tariffs for the sale of power.

Notably, the Act did not distinguish between distribution and retail supply. Distribution companies may engage in distribution, trading and retail supply through one license. Alternatively, distribution companies may carry out their business through franchisees. The Act also allows for multiple licensees or competing companies in distribution and encourages the development of parallel networks for better efficiency and competitiveness. Open access or third party access to intrastate network infrastructure was permitted and states were required to introduce it in phases, varying with consumer size. However, to discourage consumer flight from the distribution companies, states also were permitted to impose a "cross-subsidy surcharge" on consumers that opt for open access. While the Act allows for "private participation" in generation and distribution, it did not explicitly mention privatisation.

In addition to promising "electricity for all" by 2012 (which, of course, has not yet materialised), the Act also outlined detailed rules on the constitution and functioning of independent SERCs, empowering them with most functions, including tariff determination. The Act provided for consumer appellate tribunals and for the holding of public hearings by the Central and State Electricity Regulatory Commissions prior to approval of important regulations. Finally, the Act required the federal government to introduce a National Electricity Policy, a National Tariff Policy and a National Electricity Plan.

1.2.2. National Electricity Policy

The National Electricity Policy (NEP) was announced on 12th February 2005 as per the provisions of section 3 (1) of the EA 2003. The NEP aims at:

a) Access to Electricity - Available to all households in 5 years;
b) Availability of Power - Demand to be fully met by 2012. Energy and peaking shortages to be overcome and adequate spinning reserve to be made available;
c) Supply of reliable and quality power of specified standards in an efficient manner and at reasonable rates;
d) Per capita availability of electricity to be increased to over 1000 kWh by 2012;
e) Minimum lifeline consumption of 1 kWh/household/ day as merit good by year 2012;
f) Financial turnaround and commercial viability of electricity sector; and
g) Protection of consumers' interests

The Clause 5.1 of the NEP outlines several measures to address challenges in rural electrification. The relevant extract of the Clause 5.1 is reproduced below,

" 5.1.1 The key development objective of the power sector is supply of electricity to all areas including rural areas as mandated in section 6 of the Electricity Act 2003….. About 56% of rural households have not yet been electrified even though many of these households are willing to pay for electricity. Determined efforts should be made to ensure that the task of rural electrification for securing electricity access to all households and also ensuring that electricity reaches poor and marginal sections of the society at reasonable rates is completed within the next five years."

Clause 5.1.2 stipulates the creation of reliable rural electrification systems in places where it is feasible to expand the grid through the implementation of a Rural Electrification Distribution Backbone (REDB). Furthermore, it emphasises the development of decentralised distributed generation facilities for rural electrification where the grid expansion is neither cost-effective nor technically feasible. This distributed generation may be based on conventional or non-conventional resources, whichever is most suitable and economical in the context.

Clause 5.1.5 recognises that access to grid electricity for rural households may be achieved if the host distribution licensee is able to recover the cost of supply together with the operation and maintenance expenses from the consumers. Furthermore, the Government shall provide necessary capital subsidy and soft loans for investment in rural electrification projects to reduce the cost of supply to reasonable limits.

Recognising the need of appropriate institutional framework for ensuring rural electrification infrastructure, Clause 5.1.6 recommends responsibility of operation and maintenance of rural electrification system and recovery of cost to be delegated by the host distribution licensee, following appropriate arrangements, to local authority, local governance institutions, users' association, cooperative societies, non-governmental organisations or franchisee etc.

The Clause 5.1.7 mentions the cooperation and involvement among various agencies of the State Governments, Central Government and participation of the community to achieve successful and effective rural electrification.

1.2.3. National Tariff Policy

In compliance with Section 3 of the EA 2003, the Central Government notified[2] the National Tariff Policy (NTP) on January 6, 2006 in continuation to the NEP Policy. Some of the important provisions with regard to tariff policy are:

- It has been widely recognised that rational and economic pricing of electricity can be one of the major tools for energy conservation. In terms of the Section 61 (g) of the EA 2003, it is mentioned that the Appropriate Commission (Central or State Electricity Regulatory Commission) shall be guided by the objective that the tariff progressively reflects the efficient and prudent cost of supply of electricity.
- Pursuant to provisions of section 86(1)(e) of the Act, the Appropriate Commission shall fix a minimum percentage for purchase of energy from non-conventional sources taking into account availability of such resources in the region and its impact on retail tariffs. Such percentage for purchase of energy should be made applicable for the tariffs to be determined by the SERCs within April 1, 2006.
- As it may take some time before non-conventional technologies can compete with conventional sources in terms of cost of electricity, procurement by distribution companies shall be done at preferential tariffs determined by the Appropriate Commission.
- The procurement by distribution licensees for future requirements shall be done, as far as possible, through competitive bidding process under Section 63 of the Act with suppliers offering energy from same type of non-conventional sources. In the long-term, these technologies would need to compete with other sources in terms of full costs.
- The Central Commission should lay down guidelines within three months for pricing non-firm power, especially from non–conventional sources, to be followed in cases where such procurement is not through competitive bidding.

[2] In India, a law passes into effect following notification in the *India Gazette*.

- The Tariff Policy advised that the computation of the cross-subsidy surcharge applicable to Open Access for states be based on the difference between the consumer-wise tariff and the marginal cost of supply that is avoided by the consumer moving off the state utility.

1.2.4. Rural Electrification Policy

In compliance with Section 4 and 5 of the EA 2003, the Government of India notified the Rural Electrification Policy (REP) on August 23, 2006. The policy aimed at providing quality and reliable power supply at reasonable rates to all households by year 2009. It also envisaged the provision of a minimum lifeline consumption of 1 kWh per household per day by the year 2012.

The policy recommended grid connectivity as the primary mode of village electrification through the development of substations and augmentation of the network. However, where grid connectivity is neither feasible nor cost effective, off-grid solutions based on stand-alone systems may be developed in order that every household has access to electricity. Where neither standalone systems nor grid connectivity are feasible, the use of isolated lighting technologies such as solar lanterns may be adopted.

In case of decentralised distributed generation, the policy suggests, the facilities including the local distribution network may be developed considering conventional or non-conventional methods of electricity generation whichever is more suitable and economical. The policy also advocates utilisation of non-conventional sources of energy, even where grid connectivity exists, after evaluating its cost effectiveness. The policy mandated State Governments to prepare and notify a Rural Electrification Plan to achieve the goal of providing access to all households, mapping the electrification delivery mechanisms (grid or stand-alone) considering available technologies, environmental norms, availability of fuel, number of un-electrified households, and distance of village from the existing grid.

The salient features of the REP 2006 are presented below:

a) A village shall be deemed to be electrified if, basic infrastructure such as distribution transformer etc. is established, electricity is provided to public places and at least 10% of the total number of households in the village is electrified;
b) The policy seeks involvement of local community. The Gram Panchayat or the Village Council or equivalent shall issue the certificate for village being electrified and shall confirm the status on the end of every financial year;
c) For implementation of rural electrification programmes, higher capital subsidy is necessary. Similar capital subsidy is necessary for the distribution networks in the un-electrified remote villages;
d) The system of franchisee to be developed in a phased manner so as to monitor the projects financed under the scheme. If the conditionalities of the scheme are not implemented, the capital subsidy may be converted into interest bearing loan.

e) In order to maximise the benefits energy efficiency measures are to be promoted as a mass campaign in rural areas;
f) Exempted under Section 14 of the Electricity Act, a person, taking up the responsibility of generation and distribution of electricity in rural areas, shall be free from licensing obligations. However, technical standards and safety measures shall continue to apply.
g) Special dispensation for standalone systems of up to 1MW which are based on cost effective proven technologies;
h) For revenue sustainability and improved services, deployment of franchisee for management may be considered necessary;
i) Exempted under Section 13 of the Electricity Act, a person may procure power from the existing licensee of the area or from some other source at a price determined by Appropriate Commission.

The policy also acknowledges the role of electricity for the productive and livelihood creation in rural areas. The Policy states that electrification is very much required for productive and income generating activities such as small and medium industries, khadi and village industries, cold chains, health care, education and information technology. More specifically, the policy speaks of economic load development. It envisages that special efforts should be made to promote economic activities through electricity provision. The required coordination between electricity supply institutions and other sectors/departments such as rural industries, food processing, and cold chain etc. should be established by the respective State Governments.

Most recent policy statement with an emphasis on productive use of energy is laid down in the 12th plan document of the Government of India. Realising the fact that the electrification under RGGVY has not been able to generate adequate socio-economic impacts, the 12th Plan document recognises the need to pay more attention to the livelihood activities of women through the electrification interventions carried out under RGGVY. The Plan also focuses on restructuring RGGVY for the purpose of providing electricity for small industries and agricultural consumption.

1.3. Rural electrification programmes

In the rural electrification sector, over the years, a number of government programmes[3] (such as Kutir Jyoti, Minimum Needs Programme and the Accelerated Rural Electrification Programme) attempted to provide or enhance electricity access

[3] The Minimum Needs Programme started in the Fifth Five-year plan period (1974-79), which had rural electrification as one of the components. Kutir Jyoti Programme was initiated in 1989 to provide single point light connection to all Below Poverty Line (BPL) households. This program provided 100% grant for one time cost of internal wiring and service connection charges. The Accelerated Rural Electrification Programme (2003) which was initiated to offer interest subsidy to states for rural electrification was combined with the Kutir Jyoti programme in February 2004 to create the Accelerated Rural Electrification of one lakh villages and one crore households.

either as part of overall rural development or through specifically targeting rural electrification. However, the multiplicity of these programmes meant that the funding for each separate initiative tended to be inadequate and programme implementation was not properly coordinated or managed. Due to the financial burden that each programme imposed, utilities often showed little interest in actively engaging with these schemes and even tended to miss their own targets with respect to the electrification programmes. Furthermore, the substantial cross subsidy for rural electricity supply also made the utilities lukewarm towards electricity supply to rural areas. However, during the last decade, though, rural electrification has become a political priority, driven by the realisation of its neglect over the years, with the central government creating the necessary enabling environment through the REST (Rural Electricity Supply Technology) Mission[4] in 2001, Electricity Act 2003, National Electrification Policy 2005 and Rural Electrification Policy 2006. In 2001, the government declared the objective of 'power for all' by 2012 under the REST Mission and continued it with the launch of a large-scale electrification effort, the Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY) scheme in April 2005, by the Ministry of Power. The following sections provide details of the various rural electrification programmes prevalent in India.

1.3.1. Rajiv Gandhi Grameen Vidyutikaran Yojana

The RGGVY was launched by merging all other existing schemes of rural electrification, with the goal of electrifying all un-electrified villages/ hamlets, providing access to electricity to all households in five years, and providing 23.4 million free connections to households below the national poverty line. The scheme attempted to address some of the common ailments to rural electrification in the country such as poor distribution networks, lack of maintenance, low load density with high transmission losses, rising costs of delivery, and poor quality of power supply. Instead of only village electrification, the emphasis of RGGVY has been to facilitate rural development, employment generation and poverty alleviation by providing access to electricity to all rural households, inclusive of below poverty line households and also cater to the requirement of agriculture, small and micro enterprises cold chains, health care IT and education. The RGGVY programme is covered in more detail in Section 4.

[4] The REST Mission was launched for *electrification of one lakh villages and one crore households*. REST was designed to ensure a holistic and integrated approach to providing electricity for all by 2012, by identifying and adopting technological solutions, changing the legal and institutional framework, and promoting, financing, and facilitating alternative approaches. Under the programme electrification projects based on grid extension as well as stand-alone electrification based on distributed generation was eligible for capital subsidy.

1.3.2. Remote Village Electrification Programme

While the Ministry of Power is the nodal ministry for extension of the electricity grid, the Ministry of New and Renewable Energy (MNRE) has also been enhancing electricity access through decentralised renewable energy technologies, such as solar home systems, solar photovoltaic power plants, small hydropower plants, and biomass gasification, under the Remote Village Electrification Programme (RVEP), wherever grid extension is not feasible. The RVEP was initiated in 2001 for provision of basic lighting facilities in un-electrified census villages whether or not these villages were likely to receive grid connectivity. The scheme was subsequently modified to cover only those un-electrified census villages that are not likely to receive grid connectivity. By focusing on remote census villages and remote hamlets of electrified census villages, the RVEP aimed at bringing the benefits of electricity to people living in the most backward and deprived regions of the country. In addition to domestic use, the scheme also has the option of providing energy services for community facilities, pumping for drinking water supply or irrigation, as well as for economic and income generating activities in the village.

As of December 2011, the RVE programme has reportedly covered 12,369 villages and hamlets (MNRE, 2012). However, Palit (2013) observes that the vast majority, more than 90% of the villages taken up for electrification under RVE, were provided with solar home system or solar power plants. A central financial assistance up to 90% of the cost of the projects is provided as grant with specific benchmarks as applicable in respect of the technologies adopted for electrification. The balance 10% cost of projects can be financed through sources such as Prime Minister Gramodayya Yojana, Rural Infrastructure Development Fund, Ministry of Tribal Affairs, MP Local Area Development Fund, MLA Local Area Development Fund, and the corporate sector. The implementing agencies were given the option to raise funds from these and other sources, such as Rural Electrification Corporation, Power Finance Corporation, etc. including users, to meet their share of the cost of project.

1.3.3. Village Energy Security Programme

Another programme called the Village Energy Security Programme (VESP) was conceptualised by MNRE as a step forward to the RVE programme and attempted to addresses the total energy need for electricity, cooking, and motive power in remote villages through use of locally available biomass. The programme was initiated in 2004 with the following objectives:

- To meet village energy requirements through the use of biomass (for cooking, electrification or power) or other renewable technologies where necessary;
- To go beyond electrification by addressing the total energy requirements such as energy required for household cooking and irrigation;
- These projects would involve the installation of energy production systems: the biomass gasifiers, biogas plants, plantation activities and improved biomass cooking stoves.

Undoubtedly, the programme was ambitious having set itself the mandate of meeting rural communities' complete demand for energy services. Appropriately for such a pioneering and unprecedented program, the initial phase of VESP was intended to test the concept and the capacity of various institutions to deliver energy to remote and inaccessible communities. However, this test phase met with very limited success and most of the test projects could not be sustained. The programme was discontinued, and no new test projects have been sanctioned since 2010 (Palit, 2011).

1.3.4. Jawaharlal Nehru National Solar Mission

MNRE is also implementing the Jawaharlal Nehru National Solar Mission (JNNSM), one of the eight National Missions comprising India's National Action Plan on Climate Change. On the launch of the JNNSM, all solar energy programmes promoted by MNRE were integrated under the Mission. It has the twin objectives of contributing to India's long-term energy security and its environmentally sustainable growth. The Mission also aims to incentivise the installation of 22,000 MW of on- and off-grid solar power, using both solar PV and Concentrating Solar Power technologies by 2022, along with a large number of other solar applications such as solar lighting, heating, and water pumps. The first phase (up to 2013) focuses on promoting off-grid systems to serve populations without access to commercial energy as well as on adding capacity to grid-based systems, augmenting the supply with "clean" energy.

1.4. Assessment of policy and regulatory environment

1.4.1. Assessing the environment for electricity access provision using the RISE framework

This section focuses primarily on those policies and regulations which directly relate to the provision of electricity access, and uses the energy access element of the RISE (Readiness for Investment in Sustainable Energy) framework[5] for assessing the policy and regulatory environment in India. The RISE framework is aimed to help policymakers identify how they can support achievement of the SE4All goals by creating robust enabling environments for energy investment. This research builds on the quantitative assessment (Table 1) already completed for the RISE indicators with a detailed qualitative analysis to elaborate the key factors influencing the policy and regulatory environment. Thus, the appropriateness of the policy and regulatory provisions to foster electricity access in relation to each of the RISE dimensions – Planning, Policies and Mandates, Pricing and Subsidy, Efficiency of Procedure – have been considered for the analysis. As per the quantitative analysis carried out by the World Bank group, India has an overall score of 63 out of 100 as per the RISE

[5] The RISE framework was developed by the World Bank Group as part of the Sustainable Energy for All (SE4All) initiative.

framework and ranks in the middle from among the 12 countries considered for the analysis by the World Bank Group.

Table 1: RISE energy access indicators – A quantitative assessment (Source: The World Bank Group, 2014)

S N	Indicator	Score	Cumulative score
Planning			
I. Electrification Plan			
1. 1.1 1.2	Is there a national electrification plan? If yes, does it include both grid and off-grid? When was the last update?	Yes Yes 2012	100
Policies and Mandates			
II. Enabling Environment for RE Developers to invest in Mini-grids			
2. 2.1 2.2	Are there regulations outlining rights of mini-grid operators Can mini-grid operators charge tariffs that exceed the national tariff level? Do mini-grid operators need prior regulatory approval to enter into a power sale contract with businesses and residential consumers?	Yes Yes No	67
3.	Are safety, reliability, and voltage and frequency standards for mini-grids made publicly available?	Yes	67
4.	Is there any general law that deal with expropriation of mini-grids?	No	
5.	Are there duty exemptions or subsidies for mini-grid RE technology?	Yes	
III. Enabling Environment for Standalone Home Systems			
6.	Are there duty exemptions or subsidies for standalone home systems?	Yes	100
7.	Are there minimum performance standards for SHS?	Yes	
8.	Are there national programmes that promote the deployment of SHS?	Yes	
Funding and Subsidies			
IV. Funding Support to Electrification			
9.	Does the Govt. have a dedicated funding or budget for electrification?	Yes	83
10.	Does the utility or govt. cover a portion of HH connection costs?	Yes	
11.	Do capital subsidies exist for utilities to provide distribution lines to villages?	Yes	
V. Affordability of Electricity			
12	What is the relative cost of subsistence consumption? -(Cost of 30kWh/month) / (bottom 40% HH budget)	5%	1
Procedural Efficiency			
VI. Establishing a New Connection			
13.	Time and cost to connect to the grid by rural customers	29 days/ US$48	94
VII. Permitting a Mini-grid			
14.	Time and cost to provide licenses/permits to operate a mini-grid	-	-

Electrification Plan

As part of the National Electricity Policy 2005 and Rural Electrification Policy 2006, the electrification plan was developed and it was proposed to cover the entire country in five years. The RGGVY programme was launched in 2005 to achieve the objectives and both grid and off-grid was included in the plan. While RGGVY has been able to expand electricity infrastructure substantially, the number of actual households covered and electricity supply situation in many of the newly electrified villages remains poor.

Enabling Environment for RE Developers to invest in Mini-grids

Since its enactment in 2003, the Electricity Act has provided an enabling environment for renewable energy developers to invest in mini-grid thanks to the fact that the generation and distribution of electricity in notified (designated by government) rural areas does not require any license. Furthermore, the Rural Electrification Policy 2006 allows a project developer to negotiate a tariff with consumers without involving the regulator. These enabling provisions may encourage a developer to invest in the mini-grid sector.

On the other hand there is a lack of clarity regarding the details of future grid extension plans, leading to uncertainty for the developer investing in the mini-grid sector. In many cases, a developer does not know beforehand whether or not a particular area is expected to be connected to the main grid during the projected lifetime of the mini-grid installation. This uncertainty increases the risk for the investor. Furthermore, current policy frameworks and interconnection standards lack clarity regarding the legal and practical details of allowing excess generation from local mini-grid system to be fed into the conventional grid at low voltage level should the mini-grid be connected to the main grid.

Moreover, while there is subsidy support for mini-grids from the Decentralised Distributed Generation scheme under the national rural electrification program, the subsidy is associated with the capital cost only with no support provided towards the operating cost. High operating costs present severe challenges for developers of projects implemented in remote areas, where the ongoing cost of operation may be more than the original installation cost of the mini-grid and the capacity of consumers to pay higher tariffs is very limited. A subsidy regime that spreads support across both capital and ongoing costs, with the latter support being linked to performance, would better encourage mini-grid development in remote areas.

Enabling Environment for Standalone Home Systems

India has been implementing the dissemination of standalone home systems under the government's Remote Village Electrification Programme and subsequently under the JNNSM programme. Thus, certain standards and benchmarks for solar home systems are well established and have been notified by the Ministry of New and Renewable Energy (MNRE) from time to time. Additionally, the Bureau of Indian Standards is currently working with the MNRE to develop further quality standards for solar products. A subsidy is also available for solar home systems, which is offered by the Ministry through the National Bank for Agriculture and Rural Development and implemented through the Regional Rural Banks. The subsidy is around 40% with the balance of the cost to the end user being financed by the respective Banks. However, the Banks require the beneficiary to offer collateral for securing the loan, which many rural households are unable to provide and are thus prevented from benefitting from the programme.

Funding Support to Electrification

The Indian Government has been implementing the National Rural Electrification Programme since 2005 through both grid extension as well as decentralised distributed generation. The government has approved a dedicated budget for the programme. The programme supports the installation of electricity distribution infrastructure, including connections for Below Poverty Line (BPL) households, by providing up to 90% of the project cost. While infrastructure creation has been supported and the grid expanded at a rapid pace to the villages, unfortunately many of the potential beneficiary households (excluding the BPL households) have not taken up electricity connections[6]. Moreover, the electricity supplied to rural areas is not always reliable or otherwise adequate to meet people and businesses' needs, and the billing and collection efficiency in many states is poor.

Affordability of Electricity

The centralised grid-based electricity sector in India is regulated and the regulator sets the tariffs that may be charged to customers. There are various "slabs" which make up the domestic tariff structure. BPL consumers' consumption typically falls under the threshold for the lowest slab rate (approximately INR 2-3/kWh for up to 30 kWh per month), making electricity use affordable for the poorest consumers. Furthermore, electricity for rural consumers is actively cross-subsidised: urban and industrial consumers pay more than rural consumers, despite the lower cost of supplying electricity to them. While this system means that grid-based electricity in rural areas is charged at an artificially low tariff, such benefits are not extended to mini-grid projects, meaning that mini-grid developers must charge a much higher price for the electricity services they provide in order for them to remain viable.

Establishing a New Connection

The time and cost to connect to the grid varies across different states in India, being dependent on the local distribution utilities. In some states the distribution utilities engage rural electricity distribution franchisees, who have been contracted to provide electricity services on behalf of the utilities. In such cases, the franchisees guide the consumers more closely in getting an electricity connection and so the time taken is relatively lower.

[6] As observed during studies conducted by TERI to evaluate the RGGVY programme.

Permitting a Mini-grid

Mini-grids are permitted to be installed in rural areas as per the Electricity Act 2003. The eighth proviso of Section 14 (read with Section 4 of the EA 2003) also states that a person or organisation undertaking generation, based on renewable energy or non-conventional energy sources, and distribution of electricity in a rural area (as specified by the State Government) shall not require any licence.

1.4.2. Assessing the general policy & regulatory environment for the provision and productive use of electricity access

Alongside the review of policies and regulations specific to electricity provision and use, a more limited review of the general policies and regulations affecting enterprises was carried out, drawing primarily on the reports prepared by the World Bank on the Ease of Doing Business in India (World Bank, 2014). Overall India ranks quite low at 134th position out of 189 countries as per the Index on the Ease of Doing Business. The Index analyses the ease of doing business on the following ten criteria:

- starting a business,
- dealing with construction permits,
- getting electricity,
- registering property,
- getting credit,
- protecting investors,
- paying taxes,
- trading across borders,
- enforcing contracts and
- resolving insolvency

It is mentioned in the introduction to the Ease of Doing Business Report for India that the methodology employed refers to a specific type of business, “generally a local limited liability company operating in the largest business city”. It is noted that while all the parameters may be applicable to potential users of rural electrification, the degree to which each parameter affects the initiation and subsequent operation of a formal or informal rural enterprise may be very different to the impacts for a company operating in larger cities. It is also important to note that most small and micro enterprises in the rural areas where this study is of relevance would be unregistered enterprises with annual revenues in a range that may not qualify them as taxable enterprises.

The Ease of Doing Business parameters may be of greater relevance to the companies that are in the business of establishing rural electrification projects or providing electricity services. These companies are generally registered companies with offices in cities. In this section, we address each of the parameters mentioned above and attempt to explore their applicability to these two distinct stakeholders, the electricity enterprises and the users of electricity in rural areas.

- *Starting a business*: The EoDB methodology ranks India 179th among the countries included in the methodology, indicating that the formalities and documentation required for starting businesses is time consuming, expensive and tedious and thereby hampers the initiation of new business activities. From the private sector firms operating in the rural electrification space that have been surveyed as part of the stakeholder consultations (see Section 2), it is understood that in many cases the rural electrification business is a subsidiary of the main company which has already been established earlier. Few companies expressed serious concerns regarding the starting of a new business, stating that if sufficient knowledge of navigating the documentation was available the process was simple enough. The greater concern for private developers has instead been the rigid nature of policies and schemes which promote rural electrification, which do not provide sufficient incentives for businesses to operate in a sustainable manner.

  The impact of these registration procedures on rural enterprises is minimal owing to the fact that most of these businesses run at very small scales and are unregistered and operating as family owned and run business units.

- *Dealing with construction permits*: In the decentralised electricity and the rural enterprise sector, large scale construction requiring permits is often not a requirement and hence not of relevance to the initiation and sustenance of business activities.

- *Getting electricity*: This aspect is of relevance to the rural enterprises in particular and is covered in detail in other sections of this study as well. However the key issue with securing a connection in rural areas is the long time period and tedious paperwork required. The process of securing a new connection would first involve an application to the local distribution company, following by an inspection to the household or premises to determine the load requirements, following by payment for the connection and other procedural requirements, eventually leading to the power line being drawn to the house. It has been observed that this process can take up to three-four months or longer, based on the efficiency of the local distribution company. Furthermore, a previous evaluation of the RGGVY programme conducted by TERI found that many households or micro enterprises in rural areas are not aware of the procedural requirements for getting an electricity connection, and so encounter obstacles which make the process lengthy and tedious. However, it was also found during these studies that distribution utilities are in some cases taking pro-active steps and organise consumer awareness camps in many areas and releasing connections using a ‘single window’ approach.

- *Registering property*: This aspect is of low relevance to those establishing rural electrification projects. In the case of decentralised generation projects, the land requirement is generally small and the community usually arranges the provision of land (both for community-managed and private-sector projects). In the case of stand-alone systems, the equipment is installed at the beneficiary’s house or enterprise. For central grid projects, land is usually required to install the transformers, normally on public land available in the villages. For rural enterprises registration of properties is of low relevance owing to the small space requirements for informal rural businesses and their largely agricultural nature.

- *Getting credit*: This factor is of relevance to stakeholders at both ends of the electricity access chain. For suppliers of electricity, especially through renewable energy sources and in rural areas, a number of constraints such as low paying capacities of consumers, uncertainties in revenue collection, low levels of demand and the threat of main-grid extension contribute to low bankability of their business ventures. For many new ventures in the rural electrification space, funding has largely come from government subsidies, grants or equity investment. It is essential therefore that new policies and schemes are developed to enhance the bankability of rural electrification projects and therefore their access to credit.

  For small- and medium-scale enterprises in rural areas, the most significant hurdle towards obtaining credit is the requirement for collateral, needing applicants to put up assets such as land as security for the loan. Government schemes such as the Credit Guarantee Scheme for Micro and Small Enterprises (CGMSE) assist businesses in securing credit by relaxing the requirements for guarantees.

- *Protecting investors*: for both stakeholders, this parameter is of low relevance owing to the nature of ownership of such businesses which are individually run in the case of rural enterprises or are small private companies (owned and operated by a group or entrepreneurs) in the case of private developers of rural electrification systems.

- *Paying taxes:* While India is ranked relatively low on this parameter, the low ranking is ascribed more to the procedural difficulties in paying taxes rather than the percentage of tax itself, which are similar or relatively lower (after adjusting various fiscal incentives) in India as compared to many advanced economies. For the enterprises in the electricity business, the complicated process of filing taxes often leads to higher transaction costs as these companies have to hire consultants or Chartered Accountants to negotiate the paperwork and other logistics of filing taxes. For the small rural enterprise owner, the issue of paying taxes is of lower relevance due to the following two reasons:

  - Income from agricultural sources is exempt from taxes in India. A rural entrepreneur with a small shop may still be primarily dependent on agriculture and therefore the income from the enterprise may not be shown separately and bundled with his agricultural income, which is non-taxable.
  - The income from such small rural enterprises may be below the lowest tax slab and therefore non-taxable.

- *Trading across borders*: Is of low relevance to the nature of businesses under consideration

- *Enforcing contracts*: in informally established and operated rural enterprises, this parameter is of low relevance. However, in the case of the suppliers of electricity, the parameter is of relevance and can severely impact the sustainability of the electricity supply business. This may be understood as the 'contract' between the supplier of electricity and the consumer for payment of tariffs. Developers of rural electricity systems have often pointed to low revenue collection efficiency as being the primary factor for the failure of their business ventures and the reluctance on part of the banks to issue loans for projects. In many cases, collection of tariffs is difficult, while in others it has been observed that consumers in rural areas routinely overdraw power the system, over and above the capacity they are paying for.

- *Resolving insolvency*: Is of low relevance to the nature of businesses under consideration

> A summary of the findings of this review of the policy and regulatory framework for electricity access in India, synthesized with feedback from stakeholders on the policy/regulatory environment, is presented at the end of Section 2. Conclusions and recommendations for policy makers and programme designers are incorporated into Section 6.

2. Electricity Access Provider Stakeholder Consultation

2.1. Introduction

The stakeholder consultation was carried out with the aim of understanding the impact of regulation and policy on the implementation of electricity access projects, especially for productive activities, while also focusing on technical, economic and socio-cultural constraints behind implementing and operating such projects, and on factors affecting the adoption of electricity for productive uses. The research methodology listed the following questions for investigation:

- How current policy and regulation has been successful in promoting (and/or has impeded) electricity access initiatives, especially the provision of electricity for productive applications;
- What factors, in the view of the respondents are most significant in facilitating or hampering the take-up and use of available electricity access for productive purposes;
- Any possible amendments required related to policy and regulation to enable scaling up of electricity access initiatives for productive applications;
- Considerations in the design of electricity access initiatives;
- Best practices and lessons from government and private sector for provision of electricity access for productive applications;

- Requirements for scaling up such initiatives: finance, technology, institutions, business models and level of importance given to productive activities in designing electricity access projects.

In order to solicit information on the questions stated above, a structured questionnaire was prepared and administered to obtain insights from the selected stakeholders. Stakeholders were explicitly informed that the research being undertaken was supported by DfID.

The stakeholders consulted for the study included actors from the government, donor agencies, academia/research institutes and the private sector. While the Government/Ministry and Bilateral/Donor agencies consulted generally have offices in Delhi, the other categories of stakeholder cover a broader range of geographies, including state level actors such as Onergy (Kolkata), Prayas Energy Group (Pune) and Mlinda Foundation (Kolkata).

The following stakeholders were consulted, based on which this report is prepared.

Table 2: Stakeholders consulted

Sl No	Type	Organisation	Name	Designation	Date of visit
1	**Government Agencies**	Ministry of New and Renewable Energy (MNRE), New Delhi	Mr. V K Jain	Director	4 July 2014
2		Ministry of New and Renewable Energy (MNRE), New Delhi	Dr. P.C Maithani	Director	4 July 2014
3	**Financial Institutions**	Indian Renewable Energy Development Agency Ltd. (IREDA), New Delhi	Mr. R.K Vimal	Assistant General Manager	25 June 2014
4		International Finance Corporation (IFC), Delhi	Ms. Anjali Garg	Energy Specialist	30 June 2014
5	**Bilateral / Multilateral Donor Agencies**	Gesellschaft für Internationale Zusammenarbeit (GIZ), New Delhi	Dr. Hari Natarajan	Senior Technical Expert	2 July 2014
6		Swiss Agency for Development & Corporation (SDC), New Delhi	Dr. Veena Joshi Dr. Anand Shukla	Senior Advisor-Energy Senior Thematic Advisor	3 July 2014
7		SPEED[7], Rockefeller Foundation, Gurgaon	Mr. Sanjay Kazanchi	Director	1 July 2014

[7] Smart Power for Environmentally-sound Economic Development

Sl No	Type	Organisation	Name	Designation	Date of visit
8	Project implementation agencies/ Private sector	Development Alternatives, New Delhi	Mr. Sharad Tiwari	Specialist - Energy and Enterprise Development, TARA	1 July 2014
9		Onergy Solar, Kolkata, West Bengal	Mr. Sudipta Dawn	General Manager	4 July 2014
10		Husk Power Systems, Patna, Bihar	Col. Baljit Singh	Country director and COO	23 July 2014
11		Mlinda Foundation, Kolkata, West Bengal	Ms. Sudeshna Mukherjee	Deputy Country Director	31 July 2014
12		Bihar Rural Livelihood Promotion Society (JEEVIKA), Patna Bihar	Ms. Archana Tiwar	State Programme Manager	30 Sept 2014
13	Research/ Academia	Prayas Energy Group, Pune, Maharashtra	Mr. Ashwin Gambhir	Senior Research Associate	9 July 2014
14		Sambodhi Research and Communication Pvt. Ltd., New Delhi	Mr. Swapnil Shekhar Ms. Smita Rakesh	Founder Consultant	14 July 2014
15		The Energy and Resources Institute, New Delhi	Mr. I.H Rehman	Director	17 July 2014

In addition an informal consultation interview was held with Mr Greg Briffa, Team Leader Climate Change & Development at DfID-India, and feedback from that interview has been incorporated into the summary of the stakeholder discussions below.

The stakeholders willingly participated in these discussions and shared their views on the current electricity scenario in India by highlighting the policies and regulations that existed. Examples are quoted from their experiences, highlighting the factors that were significant in facilitating or hampering the use of electricity for productive purposes. They also shared their views on appropriate technologies, business and institutional models and made suggestions on how to enhance linkages between these models and productive activities.

The questionnaire used for the study was divided into three thematic parts on the basis of the nature of the questions for better analysis of the stakeholders' views on the topic in question. The themes are as follows:

a) The role of the current policy and regulatory framework in facilitating or impeding provision, take up and productive use of electricity access (and suggested changes) – Questions 6 to 10

b) Non-policy factors affecting provision, use and scale-up of electricity for productive purposes – Questions 4, 5, 11 and 12
c) Lessons learned on best practices and suggestions for designing and delivering electricity access – Questions 3, 13 to 15.

Inputs on the three thematic areas mentioned above from the four categories of stakeholders (government, donor agencies, academia/research institutes, project implementers/the private sector) are summarised in the sections below.

2.2. Policy/regulatory factors affecting provision, take up and productive use of electricity access

Stakeholders were consulted about current government policies and regulatory frameworks that played a role in facilitating or impeding the use of electricity for productive purposes. The response from most of the stakeholders indicated that though the government had made efforts to provide electricity access through several key policies and programmes, there is no particular policy which explicitly promotes the productive use of energy. However, there are a few examples of government programmes, from the past or presently being implemented, which have tried to link productive uses to electricity. Such programmes are quoted along with examples to show their impact at the village level. The key views expressed by stakeholders were:

- **The focus on productive applications in current rural electrification schemes needs to be enhanced**: Government agencies mentioned that while there are several programmes for energy access in rural areas, their focus is not on productive applications. Productive use finds mention in some of the programmes; the Remote Village Electrification Programme was an example of such a programme until it was discontinued in 2013. The JNNSM[8] feeder separation programme[9] which is being taken up in some states and the MNRE programme on solar pumping also promote the productive use of electricity.

  A few examples also highlight the ways in which the use of electricity for productive purposes can be discouraged as a result of the design of schemes or the method of implementation. One of the experts quoted the example of RGGVY[10], which was initiated with the goal of having productive uses as one

[8] **JNNSM**: The Jawaharlal Nehru National Solar Mission (JNNSM) is a major initiative of the Government of India and State Governments to promote ecologically sustainable growth while addressing India's energy security challenges. It will also constitute a major contribution by India to the global effort to meet the challenges of climate change.

[9] Installing separate electrical feeders for domestic and agricultural purposes.

[10] **RGGVY:** In 2005 the government of India started the Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY) to electrify all un-electrified villages / habitations and to provide access to electricity to all rural

of the major design parameters. However, as the programme was implemented, its focus shifted towards providing electricity for lighting only. One visible outcome of this is that to date the government has mainly installed single phase transformers, which are of lower capacity than those which can support the productive uses of electricity.

The Madhya Pradesh government's agricultural electricity supply programme was provided as a second example. The government gave temporary connections to agricultural farmers to use electricity for irrigation purposes during the sowing season. The distribution company also provided a temporary transformer, which was given to the farmers at a very high price. The farmers were required to pay an advance for three months, for which no subsidy, gap funding or grants were provided. Due to the demand being seasonally recurring and the price being high for the marginal farmers, it resulted in the farmers' inability to pay and therefore ruled out the possibility of taking up electricity access for productive purposes.

Thirdly, it was mentioned that in rural areas programme beneficiaries were expected to start using electricity for productive purposes, and thus providing the expected returns to project developers, within 6 months. However, in reality the returns from productive uses may only begin to materialise 3 to 5 years after project implementation. There was thus a need for an agency/scheme to bear the expenses for the incremental period without any returns, and an appropriate funding mechanism to be developed. In place of the capital-based subsidy schemes currently being executed, which offer funding support only at a single point in time, it is important to develop schemes that can support such projects over a longer time period through generation-based incentives or some other grant mechanism linked to ongoing operation.

Even though the word 'subsidy' has become unpopular in the field of electricity sector reform, it still has relevance in many cases in view of the need to electrify low-demand, inaccessible rural areas. For instance, in the case of Chhattisgarh state, a proactive policy initiative has been implemented by the state government with the aim of funding the provision of a lifeline tariff for mini-grid projects. The initiative, which is similar to one put into effect for central grid-connected consumers in the state, has been one of the key drivers for the successful operation of mini-grid projects in Chhattisgarh (Palit and Sarangi, 2014). The universal access fund can provide capital and operating subsidies with competitively determined, output-based aid targeted at the 'base of pyramid' consumers, along with differential tariffs to bridge any financial viability gap.

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households in un-electrified and electrified villages in the entire country in a time bound manner. For details on RGGVY, please refer to Section 3.2.

The stakeholders were also of the view that productive applications were not given enough importance at the design stage of policies and government programmes. Sometimes when productive activities were considered in programme design, they were only included in order to attract private players (by ensuring higher plant load factors or enabling tariff collection at higher rates than for domestic connections). One of the donor agencies gave an example of a large hydro-based grid-integrated project which was initiated in order to take care of lighting needs. The project itself became a source of employment for the locals during construction and early operation. However, this new employment could not be sustained for very long, and the anticipated uptake of electricity for purposes beyond lighting did not materialise. The programme was discontinued as not being economically viable because lighting loads alone were insufficient to meet the capacity that the plant was designed for.

- **Electricity provisioning is viewed as infrastructure development and the service aspect of electricity is not given due focus:** Donor agencies believed that the government did not make any provision for the service aspect of electricity, with all policies and programmes focused on the infrastructure development side. The examples of the RGGVY programme or the Decentralised Distributed Generation (DDG) scheme implemented by the Ministry of Power (MoP), which concentrate only on infrastructure development, were quoted to support the statement.

- **Discrepancies in the planning, quantity and quality of urban and rural electricity infrastructure:** A comparison of the state of rural and urban electricity provision was also brought up during the discussion. It was highlighted that in the rural context there was a defined amount of energy that the end users were provided with, unlike the urban context where a consumer could use electricity as per their demand. This was felt to be because, in the urban context, energy planners consider electricity access as an infrastructure investment for the future. Such investments were not being made in the rural context, where the emphasis was still being laid on lifeline electricity provisioning and subsidies.

  The second aspect where a discrepancy exists is the quality of electricity supplied in urban and rural areas. The discussion brought out that unless there is an uninterrupted supply of electricity with minimal voltage fluctuations, the end users struggle to use it for productive purposes. Hence, government policies should promote the supply of <u>good quality</u> energy, which would automatically lead to its take up for productive purposes.

- **State-level rural electrification planning:** The Electricity Act 2003 mandates each state to develop its own rural electrification plan, but many states are yet to do this. Stakeholders felt that if each state had a plan and achievements summary of its own it would help in maintaining data on the projects already implemented and ensure better execution of future projects (if the data generated is made available in the public domain).

- **Acceptance of new technologies:** Respondents discussed the reluctance of government agencies to accept new technologies that could help reduce cost of production and increase the reliability of electricity service delivery. An example of institutions' unwillingness to accept lithium ion batteries as a viable alternative to lead acid batteries was given to illustrate the issue. It was also felt that new policies should no longer regard renewable energy as a peripheral source but a central source for electricity supply at local level.

2.3. Non-policy factors affecting provision, use and scale-up of electricity for productive purposes

Apart from factors related to policy and government regulation, there are various other factors which affect the use of electricity for productive purposes. The important factors that emerged during the discussion were:

a) Vocational training education for skill development for end users;
b) Availability of financing facility with simplified processes and low interest loans;
c) Access to appropriate technology; and
d) Availability of infrastructure such as communication and transport.

These factors along with other points that were deemed important by the stakeholders are explored in detail below:

- **Weak or non-performing electricity institutions in rural areas:** While a variety of local institutions exist in rural areas, they are currently not adequately equipped to facilitate the use of electricity for productive applications. In many cases rural consumers are unable to get information about new government schemes which may aid them to make productive use of electricity, whether by adopting new processes or developing new enterprises for which electricity could be used as an input.

  The role of Distribution Companies (DISCOMs) is considered to be essential for the uninterrupted supply of electricity in rural areas served through the grid. The respondents felt that the DISCOMs must be more functional, profitable and autonomous in order for the systems to run better. This would aid by speeding up processes for securing connections, enabling faster responses to complaints and delivering streamlined revenue collection, thereby both serving consumers better and improving the health of the DISCOMs.

- **Access to finance, market linkages and skill development for new income generating activities** are factors which highly impact productive activities in a rural setting. Many of the government schemes supporting energy projects make no provision for finance to assist individuals or enterprises with the cost of electricity access itself or the procurement of productive equipment. Often the end users of electricity are not able to access support from private financial institutions due to factors such as their lack of documents (essential for financial transactions) and their inability to provide collateral for loans. Market linkages and skills requirements are also among the most severe barriers to the successful uptake of new productive activities. Facilitating the development of local capabilities to micro-finance, assemble, supply and service electricity access technologies and systems will not only facilitate enterprise development on the supply side, but could potentially enhance livelihood activities.

- **Reliability of quantity and quality of electricity:** Reliability of electricity is viewed as another important contributing factor by all stakeholders in order for people to take up electricity access for productive purposes.

- **Integration of electricity access with existing economic activities:** Electricity can be successfully used for productive applications when it is linked to an economic activity which is already present in the area. In the absence of a pre-existing economic activity in the region, new activities have to be introduced, the success of which often depends also on the dissemination of training and skill development, the creation of market linkages and the provision of finance. The activity, if introduced externally, must also be culturally and practically acceptable to the community. When improved electricity access is provided to an existing livelihood activity and other factors such as market linkages, skill development, demand for the product in the market, etc. are already in place then electricity is more easily taken up and used for productive purposes.

- **Integration of electricity access with other relevant government programmes:** An important factor highlighted is the lack of integration between different government programmes, which failed to confer the benefits that the end users could otherwise have enjoyed. Stakeholders felt that while progress is being made in this respect, there remains a need for coordination and integration across different ministries and agencies, and for a mechanism to bring different players together on a single platform to work together to promote better use of electricity access. For example, the National Rural Livelihood Mission (NRLM)[11] of the government of India could be integrated with the energy access programme to provide better market linkages and microfinance facilities to the beneficiary communities. However, difficulties were anticipated for hybrid programmes regarding the division of responsibility, setting objectives, measuring performance and budgetary planning.

[11] **NRLM:** National Rural Livelihood Mission (NRLM) is a poverty alleviation project implemented by Ministry of Rural Development, Government of India. This scheme is focused on promoting self-employment and organisation of the rural poor into SHG (Self Help Groups).

Another useful linkage could be formed between the Ministries of Energy and Health. Other stakeholders suggested that the Ministry of Rural Development, the state rural development departments or the District Administrations could act as the nodal agency(s) for infrastructure development of all rural areas around which other departments/programmes could fit.

There is also a need for convergence at the planning level, and it was suggested that NABARD's[12] state level plan could be converged with MoP/REC's electrification plan in order to promote the use of electricity for productive purposes.

- **Lack of infrastructure:** Lack of infrastructure is perceived as the biggest hurdle by many respondents. Non-availability of basic infrastructure like transport and communication facilities and lack of access to technology or modern appliances are other factors that hamper its use for livelihood generation.

- **Cost of electricity:** Often, the comparison of off-grid electricity prices to that of energy provided through grid discourages people from taking up electricity connections from off-grid interventions. However, other factors may serve to encourage uptake; often the reliability of off-grid energy in comparison to that of grid is an important motivator. Most respondents believe that while the costs are high at present, they are rapidly declining owing to improvements in technological efficiency. If supported through correctly designed incentive schemes, it is likely that even off-grid technologies will become affordable for productive applications in rural areas.

- **Complex procedures for new connections:** Stakeholders felt that simplifying the procedures and processes for establishing new connections would encourage uptake. An example from the Maharashtra government was cited, where it was decided that small commercial units established inside houses would be charged the same tariffs as domestic consumers. This move greatly reduced the time and effort (especially in terms of documentation) required to secure an electricity connection for small commercial establishments, and has resulted in increased take up and use of electricity for productive purposes.

Assessing the factors other than electricity that facilitate or hamper the use of energy for productive purposes, the stakeholders shared experiences and lessons from their projects. It is emphasised that the existence of a livelihood activity prior to electrification, along with market linkages and availability of finance, plays a very

[12] **NABARD:** National Bank for Agriculture and Rural Development (NABARD) is an apex development bank in India, whose mission is to promote sustainable and equitable agriculture and rural prosperity through effective credit support, related services, institution development and other innovative initiatives.

important role in the uptake of electricity for productive purposes. An existing economic activity also ensures that the person possesses the skills to execute the activity and no external training is required. The scale of economic activity is also important, which ensures substantial returns to pay for the electricity. Another factor which facilitates the use of available electricity for productive purposes is the availability of resources and raw materials in the area. Furthermore, productive use-promoting projects are more likely to be successful in areas where the size of the economy is larger and economies (and practicalities) of scale can be exploited. For example, some productive activities may be viable when a cluster of villages can become involved together but would not be viable for a single village.

2.4. Lessons learned and best practice

Delivery models

Stakeholders generally felt that the public-private partnership (PPP) model is ideal for the development of off-grid electricity projects in India. Under this model, the government would act as facilitator and create an enabling environment, while the implementation would be executed by private partners.

Stakeholders were not in agreement regarding the role of subsidies in electricity access provision. Whilst most were in favour of subsidy as a means of assisting the poor and catalysing markets, some respondents felt that models should not be subsidy driven or that there should be innovation around the structuring of subsidies in order to deliver the desired outcomes at a lower cost.

Electricity access project mapping

As an aid to planning and a mitigator of risk for developers, stakeholders suggested that mapping of the locations where energy access projects have been or are planned to be implemented should be developed and maintained. Such a tool would allow electricity access programme developers to avoid replication and overlapping, particularly for off-grid projects in areas that may be destined for grid extension. There is currently little incentive for mini-grid developers to initiate off-grid electricity projects in all but the remotest areas in the absence of information about the timing and location of grid extension. The proposed mapping could additionally provide clarity regarding the locations and boundaries of “notified” areas[13] for the establishment of off-grid power plants.

[13] Off-grid power plants are regulated differently in notified areas, for example developers and operators do not require licences or permits in notified areas.

Designing for productive uses

Several agencies which implement large scale projects were of the view that productive load should be taken into consideration during initial surveys and project design in order to determine plant capacity. Accurate prediction of demand would produce better outcomes than the trial and error method that prevails in practice. However, stakeholders were keen to point out that this assessment is normally location- and context-specific, with lessons from one programme not necessarily being applicable to others.

Furthermore, the current national electrification plan does not guarantee the number of hours of electricity supply that will be provided to productive users. This makes the economics of a particular intervention difficult to predict given that the amount of money that will be generated as a result of productive activities (and through which people and enterprises are able to pay for electricity services) is uncertain.

Quoting an example from an implemented project, one of the donor agencies described a water mill scheme in the state of Uttarakhand in the Himalayan region that was intended to promote productive activities. The project developed a business model involving clusters of water mills, around which Self Help Groups (SHGs) were created. These SHGs procured grains, processed and packaged them and sold them at a small premium. The initiative was appreciated at the state level, and an attempt was made to link it with the official livelihood programme. However, the project ran into difficulties regarding funding sources, with MNRE (who was part-funding the project) taking the position that the scope of work of the project was to provide access to energy and not to develop the entire value chain.

Technologies

Many stakeholders felt that biomass gasifiers are the most suitable off-grid technology for productive uses of electricity. Solar mini-grids are also a viable option because of easy monitoring and maintenance.

Addressing unreliability of supply

The need was voiced for better communication between the DISCOMs and local agencies such as the Village Electricity Committees (VECs), so that any faults at the village level which cannot be addressed locally can easily be communicated to the DISCOM for immediate action. Currently, there are no systems that could bring these agencies together on a single platform to engage in mutually beneficial dialogue.

2.5. Developing the findings of the Literature Review "*What level of electricity access is required to enable and sustain poverty reduction?*"

A Literature Review was carried out as part of the *Utilising Electricity Access for Poverty Reduction* project. The researchers conducted an exhaustive review of available literature on electricity access and identified a range of barriers which adversely impact the uptake of electricity for productive purposes. In addition to this, the Review also collates information on some of the external factors that can contribute either positively or negatively to the uptake of electricity for productive purposes. Some of the key points highlighted by the Review include:

- Greater linkages and cooperation are required between electricity access and programmes and other developmental initiatives
- The quantity and quality of electricity are the most critical factors contributing to the development of rural enterprises
- Other critical factors include the presence of adequate infrastructure (such as roads, transport, and communication), financial institutions and the availability of credit and skills development initiatives.

While the review demonstrates that at lower levels of electricity access the literature showcases a positive impact of electricity on both income and extended hours of work, it also concludes that the impact of electricity for higher levels of access is not adequately documented and therefore inconclusive. It is suggested that this lack of evidence is also due to the difficulty in establishing linkages between electricity access and income generation owing to the large number of factors relating to market and skill development which contribute to enterprise development. This has direct relevance to electricity policy in India, specifically in terms of the linkages that need to be created between electricity policies and other developmental programmes and policies.

Interaction with respondents during the field surveys and the discussions with various stakeholders highlighted this key message – that greater coordination is required between electricity access policies and other relevant developmental policies such as those related to skills development, Small and Medium Enterprises, agriculture and other activities prominent in rural areas. The lack of adequate markets and skills sets and the existence of poor quality infrastructure such as roads, communication facilities, make it difficult for small scale enterprises to develop purely as a result of the availability of electricity. While the Rural Electrification Policy mentions that coordination between the electricity supply departments other Government departments should be made, there is little evidence of the execution of the same on the ground.

Secondly, it is also observed that a majority of rural electrification schemes in India focus largely on the Below Poverty Line (BPL) population and the provision of lifeline electricity services to them. The focus so far has not explicitly been on the promotion of productive uses, although as mentioned in previous sections, the policies do mention the importance of electricity for productive purposes. It is therefore crucial that the role of existing policies is examined further, from the point of view of explicitly providing incentives to productive activities.

One way in which such a move has been executed in India is the separation of household feeders and agricultural feeders in some states of India. Electricity to rural areas has traditionally been supplied to two main types of consumers, households and agriculture. As agricultural use of electricity for water pumping is highly subsidised, it often leads to overuse of electricity and therefore losses to the supply company. When domestic and agricultural feeders are combined, it means that overuse of subsidised power through agricultural pumpsets continues as long as power is available on that feeder (16-20 hours when households are supplied from the same feeder) thereby leading to large losses as well as power quality problems from the overuse of agricultural pumpsets. Under the feeder separation programme, separate feeders for agricultural use (having about 6-8 hours of supply) are installed. The other feeder supplies power to habitations which include both households and small commercial enterprises, and supplies power for more than 16 hours a day.

A key outcome of this initiative has been the assurance of high quality and uninterrupted power on both feeders. Case studies[14] on the feeder separation programme in the state of Gujarat (the Jyotigram Feeder Segregation programme) demonstrate how this reliability of power has led to the establishment of new small and medium enterprises in the rural habitations. The success of this programme in this state is now being translated to a national level through the recently launched Deendayal Upadhyaya Gram Jyoti Yojana scheme for feeder separation declared during the 2014-2015 Budget. INR 5000 million (US$81 million) has been sanctioned for the programme in the 2014/15 financial year.

Another crucial factor identified in the review as impacting the uptake of electricity for productive purposes is the cost and time required for securing an electricity connection and the subsequent cost of electricity. This factor becomes particularly important in cases when the only electricity solution available is the main grid being extended by the government. However, the Electricity Act 2003 and subsequent policies have identified and promoted alternatives in the form of distributed generation power plants involving local governance institutions, users' association, cooperative societies, non-governmental organisations or franchisees. The promotion of such local initiatives and the inclusion of privately owned and operated power plants are measures aimed at improving the quality of service as well as the ease of securing a connection in remote rural locations.

Affordability of electricity is another factor identified in the Review as being critical to the development of productive uses of electricity. While Indian policies have been progressive in their promotion of distributed generation options as stated above, adequate monetary support to the developers of such systems in the form of smart subsidies that can reduce cost of generation of power are not yet available. Rather, pure capital subsidies are provided which are not successful in bringing down the cost of generation of distributed generation options to the levels of grid-electricity tariff, which are regulated and cross-subsidised. Therefore while there are some schemes to promote distributed generation, the tariffs required to sustain these power plants is still high compared to the prevalent grid-tariff, making them non-

[14] http://indiasmartgrid.org/en/Lists/TechnologySessionFiles/Attachments/12/Gujarat%20Case%20Study%20on%20Agricultural%20Feeder%20Seperation.pdf

competitive. This directly impacts the end-user as well, who is unable to compete in a business activity with a competitor who is operating in a nearby village which received reliable grid-electricity.

Box 1: Policy/Regulatory Summary

1. In absolute terms, India's progress in terms of electricity access has been laudable. However, the challenge of providing electricity to the 300 million who lack access is still immense and government targets are regularly missed.

2. Under the provisions of the Electricity Act 2003, progressive deregulation of the off-grid electricity access space (licensing, tariff-setting, etc.) and subsidy support for mini-grids from the Decentralised Distributed Generation scheme have encouraged off-grid developments.

3. India's numerous rural electrification/electricity access programmes have often been under-resourced and failed to deliver the expected benefits. There is a strong need for co-operation between different government departments and ministries, and convergence between electricity access programmes and livelihood/enterprise development initiatives.

4. There is lack of clarity regarding the details of future grid extension plans, leading to uncertainty for the developer investing in off-grid electricity access.

5. Electricity access for productive uses has received little attention from policymakers. Programmes which originally aimed to promote productive uses have tended to drift away from this objective.

6. Cross-subsidisation and heavily subsidised 'lifeline' tariffs help the grid-connected poor to access electricity, but create a challenging environment for off-grid electricity provision

7. Standards and benchmarks for SHS are well established with standards for other solar products under development. A 40% subsidy is also available for purchasers of SHS.

Box 2: Electricity Access Provision Summary

1. Electrification programmes tend to consider the aim of rural provision to be supplying only 'lifeline'-level electricity access to the poor rather than developing electricity services that enterprises can use to generate value.

2. Electricity access provision for productive uses tends to generate the best outcomes when there is a pre-existing economic activity that can be adapted to take advantage of electricity, and when the size of the local economy is large enough to make an activity viable.

3. Electricity access should be provided alongside initiatives to tackle market linkages and skill development, especially where new productive activities are expected. Beyond electricity infrastructure, good roads, bridges and communications infrastructure are necessary for enterprises to take advantage of electricity.

4. Adequate reliability, capacity and quality are essential for the productive use of electricity access.

5. End users need access to better finance facilities to help them obtain electricity access (including appliances for productive use) and establish small scale enterprises.

6. There is a real risk of duplication and overlap for programme and project developers which could be mitigated by the compilation of open access mapping tools.

3. Programme Case Studies

3.1. Methodology

3.1.1. Selection of Programmes

A detailed review of electricity access programmes in India was undertaken to identify four programmes to form the basis of the field studies. In carrying out this review we have sought to identify programmes which encompass a range of:

- Means of energy access provision (including main grid extension, mini-grids, and standalone systems and appliances)
- Types of programme (e.g. utility/government driven, NGO/agency led, private sector)

The programmes selected were such that the following types of electricity access interventions could be studied:

- Main grid extension
- Mini-grid systems
- Stand-alone systems

The rationale behind the selection of programmes providing electricity services from different types of electricity access interventions was to ensure that access options along different tiers of electricity access (as defined by the Global Tracking Framework) were covered in the study. It is also important to note that the Rural Electrification Policy 2006 of India specifies that all three types of systems should be used to electrify communities, based on distance from the main grid and accessibility. It is specified that while extension of the central grid should be the first option, for communities where extension of the central grid is not feasible, decentralised systems such as mini-grids may be installed and in more remote communities, stand-alone systems may be installed. The selection of the programmes also ensured that different type of programme-implementing institutions were covered in order to understand the various prevalent institutional models and level of electricity access provided. Thus, programme implementation agencies considered included government owned distribution utility (central grid), private sector utility (mini-grid) and NGO/civil society organisation for stand-alone systems. Further, all the programmes considered for the survey are in DfID priority states in India, where DfID is working with the respective state governments to help the poor in rural villages and urban slums in the field of livelihood and access to health, education, and water & sanitation services.

Further, the selection process considered only programmes which have been substantively implemented (so that their impacts can be observed), and insofar as it is possible only programmes implemented within the past five years (so that data is relatively recent, and survey respondents may be expected to remember details about their past situation). The programme selection has also been guided by the level and quality of data about the programme and the willingness of the programme stakeholders to engage with this study. As far as possible we have focussed on programmes designed with the aim of fostering electricity access for productive use/income generating activities, and those that have been monitored programmatically and able to provide data on levels of poverty before and after programme implementation. Where appropriate an element of a larger programme, such as a single mini-grid scheme or a grid connected village within a wider programme, has been selected.

The four programmes selected are summarised in Table 3.

Table 3: Programmes Selected for Study

Sl No.	Country & state	Programme Name	Means of Electricity Access	Type of programme	Implementing Agency
1	India/West Bengal	Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY)	Main Grid Extension	Government led grid connected electricity access programme	West Bengal Electricity Distribution Company Ltd
2	India/Bihar	Husk Power Systems	Mini-grids	Private sector led entrepreneurship model	Husk Power Systems
3	India/Odisha	Lighting a Billion Lives Programme	Solar Lanterns	Civil Society led entrepreneur based model	The Energy and Resources Institute (TERI)
4	India/West Bengal	Mlinda Foundation	Mini-Grids	Civil Society led Joint-Liability Group based Mini-Grid model	Mlinda Foundation

3.1.2. Community Selection

Each of the four programmes selected for the study have electricity projects installed in different states and/or in different locations within a state. The date of installation, the remoteness of sites and the prior status of the sites (grid connected or off-grid) vary from site to site. In order to select the most appropriate sites for the study, the following key characteristics were taken into account:

- Date of installation of the electricity access project or date of extension of the grid should be between 2 and 6 years ago to ensure that the project has had sufficient time to impact the community. In addition to this, such a time period also would result in more authentic data about the past use of electricity and associated questions regarding past income while respondents may not be able to recollect data accurately over a longer time period;

- Except for the grid connected communities, it was essential that the communities where mini-grid or stand-alone systems have been installed were not previously electrified through main grid extension. Many mini-grid projects and a large number of stand-alone system projects in India have been installed by different implementing agencies in areas where grid penetration exists. As mentioned in Section 1, India has a village electrification rate of over 95% but the quantity and quality of electricity available in many remote locations is low. Hence the selection of communities where the selected programme was the first source of electricity narrows down options to a few select communities only;
- Communities were also selected such that in addition to provision of electricity serves at the households, SMEs[15] are also being served with electricity services from the programme.
- The Community selection process also considered existence of a completely off-grid community in the vicinity of the Beneficiary community where the non-beneficiaries of the programme could be surveyed. Further, the Non-beneficiary community was selected such that they are as similar as reasonably practicable (in terms of socio-economic characteristics) to the Beneficiary community. It is to be noted here that while the attempt was to identify two communities which have largely similar characteristics such as social status of residents and income profiles before the advent of electricity programme but due to the historical remoteness and isolation of the present non-beneficiary off-grid communities does contribute to some differences in the baseline income levels between the Beneficiary and Non-Beneficiary communities. Further, considering the fact that there are very few completely off-grid communities (which would qualify as non-beneficiary communities) remaining in India, the same conditions (such as remoteness, poor accessibility, lack of infrastructure etc.) that contribute to these communities continuing to be off-grid also contribute to the differences in baseline data between these non-beneficiary communities and the shortlisted Beneficiary communities. In other words, while there may be strong similarities in the types of occupation, language (dialects), caste, family structure etc. the baseline income levels of the Non-Beneficiary communities may be lower than

[15] A Small and Medium Enterprise (SME) includes a range of possible enterprises including shops, small traders, restaurants/eateries, weaving, tailoring, welding, milling enterprises etc. The SME may be located in the market-place either within or adjacent to the village and or in the household. The SME located inside a household have been considered as an SME if the accounts of the SME business are separate from the other household accounts.

those of communities where either the grid or another programme has reached in recent years.

- In identifying these communities we have also sought (across the four programmes) to include communities with a range of poverty levels, levels of productive and economic activity and scale and remoteness;
- For timeliness, ease of mobilisation and cost effectiveness, communities have also been selected from geographical areas where the TERI team maintains strong local presence either directly or through local partners.

Further, the geographical proximity of the Beneficiary Community and its Non-Beneficiary counterpart has been an important consideration. This is to ensure that the two communities are more likely to share cultural, social and environmental characteristics. While a degree of geographical proximity is also required such that the field research can be completed within the available time, very close communities are likely to affect each other as a result of their different levels of electricity access. For example, some effects of improved electricity access may ‘spill over’ beyond the boundaries of the Beneficiary Community and electricity access may be a driver of migration between two nearby communities. For this reason, when selecting the ‘control’ community we have attempted to strike a balance between using closeness as a proxy for similarity and using separation as a means to avoid unintended interactions between communities. Thus, non-beneficiary households within the Beneficiary communities as well as completely different Non-Beneficiary communities have been selected for the survey. Further, as reported in the Field Research Methodology Report, for the purpose of survey we have not considered any specific level (or lack) of electricity access for the Non-Beneficiary Community, other than the requirement that the community should not have benefitted from the programme under study.

Hence by covering these different types of communities from different programmes, the range of end-users receiving services both as per the tiers defined Global Tracking Framework and the Rural Electrification Policy of India are included. Table 4 provides the details of the sample size of each of the ‘control’ and ‘treatment’ group in each of the four programmes. Details of the selected communities under each of the four programmes are provided in subsequent sections.

Table 4: Sample size by programme

Community Type	Target Sample Size	Actual number surveyed				
		P1: RGGVY	P2: Husk Power	P3: LaBL	P4: Mlinda	Total
Beneficiary households	20-40	35	31	28	25	119
Non-Beneficiary households in Beneficiary community	10-20	10	11	15	12	48
Non-Beneficiary households in Non-Beneficiary community	10-20	12	10	12	12	46
Beneficiary SMEs	4-8	6	5	5	5	21
Non-Beneficiary SMEs in Beneficiary community	2-4	3	5	3	3	14
Non-Beneficiary SMEs in Non-Beneficiary community	2-4	3	0[16]	3	3	9
Total		**69**	**62**	**66**	**60**	**257**

3.1.3. Questionnaire

A 6-part, 600-question questionnaire was developed to enable the assessment of the electricity access levels of households and enterprises both at the time of survey and before the programme was implemented, and to measure some of the potential impacts of electricity access on households and enterprises. The questionnaire also included questions that sought to investigate the factors which encourage, or constrain, the take up and productive use of available electricity access.

The same questionnaire form was delivered to both households and enterprises, although some sections did not apply in all contexts. Data relating to enterprises and productive activities was gathered both at places of business, and via the interviewing of people in their homes who reported that they either owned or managed a business, or carried out a productive activity in their home.

3.1.4. Determination of Electricity Access Attribute Tier

The methodology for defining and measuring energy access under the SE4ALL Global Tracking Framework is still under development at the time of writing (September 2014). However, this analysis has used the various draft questionnaires and tier boundary definitions so far available to establish a methodology that follows as closely as possible the latest versions of the Global Tracking Framework. In cases of uncertainty, guidance from the World Bank-ESMAP team has been sought

[16] No SMEs were identified in Pachkaria, the Non-Beneficiary Community for the Husk Power programme

and followed as closely as possible considering the timeline of the study. When new information regarding certain aspects of the framework came to light towards the end of the research period, it was in some instances not possible to update the tier assessment because the already-delivered survey questionnaire was not compatible with the new tier assessment criteria. When such incompatibilities could not be resolved, the study continued to use the previous version of the framework.

Tables 5 and 6 illustrate the tier definitions used.

The Global Tracking Framework is designed to assess energy access in all its forms, whereas the focus of this study has been solely on access to electricity. For this reason, it has been possible to simplify and rationalise some aspects of the Framework in order to facilitate the delivery of survey questionnaires and avoid unnecessary complication with respect to the analysis of survey data.

Table 5: Household Electricity Access: Tier Definitions[17]

Attributes			Tier-0	Tier-1	Tier-2	Tier-3	Tier-4	Tier-5
t_1	**1. Capacity** Amount of energy required to support different levels of power loads	For grid, mini-grid or standalone generators:	< 1 W	1-50 W	50-500 W	500-2000 W	>2000 W	>2000 W
		For battery-based systems:	< 2 Wh/day	2-200 Wh/day	200 Wh/day – 1.2 kWh/day	> 1.2 kWh/day	see note[18]	
t_2	**2. Duration/Availability** Average duration during which the primary energy source is available compared to the average duration during which it is required.	Total Supply (Required: 24 hrs)	<4 hours		4-8 hours	8-16 hours	16-22 hours	>22 hours
		AND	*Select lowest tier indicated by Total Supply or Evening Supply*					
		Evening supply (Required: 4 hrs)	< 1 hour	1-2 hours		2-4 hours		4 hours
t_3	**3. Reliability** Unscheduled outages/breakdowns in energy supply	No more than three unscheduled outages or breakdowns per week of more than 30 min each				No		Yes
t_4	**4. Quality** (Voltage)	Drops or fluctuations in quality parameters are only minor and rare with little or no impact on energy operations			No			Yes
t_5	**5. Affordability** Ability to afford the use of primary source of energy for required applications	Ratio of monthly expense for a consumption package of 162 kWh to monthly income		>10%				<10%
t_6	**6. Legality**	Energy supply is obtained through legal means (bill received or payment made)			No			Yes

[17] © International Energy Agency and World Bank, 2013.

[18] The highest tier that battery-based systems can achieve is Tier 3.

Table 6: Electricity Access for Productive Uses: Tier Definitions[19]

If the relevant application is needed but not used due to energy-related issues, the tier rating for that application is 0.

Attributes			**Tier-0**	**Tier-1**	**Tier-2**	**Tier-3**	**Tier-4**	**Tier-5**
t_1	**1. Capacity** Amount of energy required to support different levels of power loads	For grid, mini-grid or standalone generators:	< 1W	1-50 W	50-200 W	200 W – 2 kW	2 – 10 kW	> 10 kW
		For battery-based systems:	< 2 Wh/day	2-200 Wh/day	200 Wh/day – 1.2 kWh/day	> 1.2 kWh/day	see note [20]	
t_2	**2. Duration/Availability** % of usage hours	Average time electricity source available divided by the average operating hours	Less than 25%	25%-50%	50%-75%		At least 75%	100%
t_3	**3. Reliability** Unscheduled outages/breakdowns in energy supply	Number of unscheduled outages per week Cumulative length of unscheduled outages per week						< 4 outages *AND* < 2 hours
		THEN	*If reliability does not meet Tier 5 criteria, assess tier using impact on business operations*					
		Impact of unscheduled outages on business operations			Severe impact		Moderate impact	Little or no impact

[19] © International Energy Agency and World Bank, 2013.

[20] The highest tier that battery-based systems can achieve is Tier 3.

t_4	**4. Quality** (Voltage)	Experience of situations in which appliances cannot be used or may get damaged because of low voltage or voltage fluctuations						Not experienced
		THEN	*If situations are experienced, assess tier using impact on business operations*					
		Impact of low voltage or voltage fluctuations on business operations			Severe impact		Moderate impact	Little or no impact
t_5	**5. Affordability** Ability to afford the use of primary source of energy for required applications	Ratio of monthly expense for a specified consumption package to monthly income			Cost is higher than 2 times the grid tariff		Cost is 1-2 times the grid tariff	Cost is less than or equal to grid tariff
t_6	**6. Legality**	Energy supply is obtained through legal means (bill received or payment made)			No			Yes
t_7	**7. Health & Safety** (electrocution, air pollution, burning risk, drudgery)	The electricity supply system has in the past or is likely to cause electrocution, pollution (fumes/smoke), burns or physical harm from drudgery		Solution has or is likely to cause **severe** damage		Solution has or is likely to cause **moderate** damage		Solution has not and is not likely to cause damage
t_8	**8. Convenience**	Obtaining fuel/batteries or maintaining the electricity source subtracts relevant time from the productive activity and reduces business productivity				Yes		No

3.1.5. Impact Indicators

The possible impacts of improved electricity access in terms of productive activities were investigated via a number of questions regarding the enterprise and its performance. The surveys were designed to probe the following impacts:

- Enterprise revenue, both current and past (if revenue has changed significantly since the programme was implemented)
- Enterprise profit, both current and past (if revenue has changed significantly since the programme was implemented)
- Enterprise creation, by recording when the enterprise was started
- Employment, both current and past (if the number of employees has changed since the programme was implemented)
- Employee remuneration, both current and past (if the employee remuneration has changed since the programme was implemented)

In the communities in which the surveys were carried out, the number of enterprises employing people was very small. Most enterprises were family businesses, or people carrying out productive activities themselves in their homes. This meant that very little data existed with respect to the latter two impact indicators (employment and employee remuneration) and no conclusions could be drawn about the impact of improved electricity access, other than that it had not encouraged enterprises to employ people outside the family.

The possible poverty impacts of improved electricity access were assessed via the household surveys. Respondents were asked about the following:

- Household income, both current and past (if income has changed significantly since the programme was implemented)
- Employment status of the interviewee, both current and past
- If the household had any children, if there had been any change in the education that was available to them since the programme was implemented
- If there had been any change in the health care that was available since the programme was implemented

Both enterprise and household respondents were also asked to what degree they attributed any improvement in these indicators to improved electricity access for themselves, and for their wider community.

3.1.6. Data Analysis

The survey data was collated and analysed in order to establish patterns and relationships between electricity access (or the lack of it) and the selected impact indicators.

Electricity access tiers were first calculated by assessing the *attribute tiers* across the attributes defined by the Global Tracking Framework:

Household Energy: Capacity, Duration/availability, Reliability, Quality, Affordability, Legality

Productive Uses of Energy: Capacity, Duration/availability, Reliability, Quality, Affordability, Legality, Health and Safety, Convenience

For productive uses and enterprises, attribute tiers were calculated separately for as many of the six ‘applications’ covered by the Global Tracking Framework (lighting, ICT and entertainment, motive power, space heating, product heating and water heating) as were relevant to the enterprise and for which electricity was regularly used. Relevancy was assessed by asking whether the application was ‘strictly necessary’ in order to carry out the productive activity, or whether the business would suffer in terms of productivity, sales, costs or quality without that application.

The overall tier for households, or the application tier for enterprises, was calculated according to the Global Tracking Framework protocol by selecting the lowest attribute tier. The overall tier for enterprises was calculated by taking the average of the application tiers which had been assessed.

For productive uses of electricity, the numbers of enterprises using each of the six ‘applications’ covered by the Global Tracking Framework (lighting, ICT and entertainment, motive power, space heating, product heating and water heating) and the average tier achieved for that application were calculated.

For households and enterprises, and for each application where applicable, the numbers of respondents achieving each level for the attribute tiers were calculated in order to establish which attributes tended to constrain the household/enterprise’s access level most frequently.

Electricity access tiers and indicators were calculated separately for beneficiaries and non-beneficiaries[21] of the programme. These two groups were compared both in terms of average access levels and indicators (and changes in access levels and indicators), and by correlating various measures of access levels and indicators.

All the four programmes studied provided the majority of their beneficiaries with the same level of electricity access. Furthermore, the majority of non-beneficiaries had no electricity access whatsoever, as did both groups before the programmes were implemented. This means that the electricity access data tended to be mostly binary (0 / 1, 0 / 2 etc.). The correlation coefficients calculated are a measure of the positive/negative nature of the relationship. However, the binary nature of the electricity access data means that it must be recognised that, rather than describing conformity to a linear relationship, the correlation coefficients are instead describing the spread of the impact indicators within each electricity access level.

[21] Non-beneficiaries could be from the Beneficiary Community (but did not themselves receive improved electricity access via the programme) or from the Non-Beneficiary Community.

Enterprises owned or managed by household respondents were considered to be Beneficiary regardless of their location.

The following boundaries were used to determine the significance of a correlation:

Pearson's Correlation Coefficient	R-squared / Coefficient of Determination	Strength of Correlation
0 – 20%	0 – 0.04	Negligible
20 – 40%	0.04 – 0.16	Weak
40 – 70%	0.16 – 0.49	Moderate
70 - 100%	0.49 – 1.00	Strong

3.1.7. Community Feedback Workshop/Focus Group Report

After the completion of the household and enterprise level survey, a discussion was held with the members of the surveyed communities. The aim of the discussion was:

1. To inform the community members of the findings from the survey and to validate those findings;
2. To know more about the energy requirements of the community, and the extent to which they were presently being met;
3. To know more about the problems faced by them regarding electricity services and systems; and
4. To explore the changes to the current system that the community recommend in order to make it more robust and efficient

3.1.8. Reliability of Conclusions

Potential biases exist that may have affected the responses recorded from each individual interview and the conclusions drawn.

The research was based on examination of those who had and hadn't benefitted from pre-existing electricity access programmes, and thus unavoidably incorporated any inherent biases in the selection of those who were to benefit from these programmes. Electricity access and income/wealth may be related in both directions; it is often the case that electricity access will be provided to those communities that are better able to pay for electricity, or have better infrastructure, or that are judged to be more likely to make productive use of it. The same factors may influence which people or businesses obtain electricity access within a community. On the other hand, some donors and programme implementers deliberately target the poorest communities or the poorest members of society, and so a reverse bias may exist in some cases.

To mitigate these effects the field research component largely employed a 'difference-in-differences' approach, comparing changes in certain enterprise and poverty indicators across populations classified by their level of electricity access, or the change in level of electricity access that they had experienced. To support this, surveys were carried out in paired beneficiary/non-beneficiary communities and respondents were asked for information about their past as well as present electricity access, incomes, enterprise revenues and profits etc. However, it is recognised that these approaches also have shortcomings. In particular:

a) Although non-beneficiary communities were selected to be as similar as possible to beneficiary communities in terms of location, pre-programme wealth and economic activity, there were still significant differences between the two communities in most of the programme pairs. The selection of a good 'control' community was especially difficult in India, where the majority of village centres have some level of grid electricity connection and it is mainly the hamlets that surround them that are the beneficiaries of off-grid electricity access programmes.

b) Despite efforts to reduce 'spill-over' effects by avoiding selection of community pairs in very close proximity, the need to choose pairs which are reasonably close (without which socio-economic comparability would have been difficult to achieve) mean that some such effects may remain.

c) There are limitations to the accuracy of data that can be gathered about past electricity access and the status of impact indicators relating to people's lives and livelihoods several years ago. Any findings relating to a change in electricity access or a change in an indicator must therefore be viewed with caution. Considering such findings alongside the patterns that exist in the more reliable "current situation" data can provide evidence to support or discount the "differences" findings.

d) While efforts were made to ensure those interviewed within communities were selected randomly it is also recognised that some systematic biases may remain regarding the selection of interviewees on, for instance, a geographic basis (ease of access, remoteness, type of land use) and a demographic basis (time of day, cultural, age and gender effects).

The enterprises surveyed included both standalone businesses and enterprises based on productive activities carried out within the home. They also spanned a range of businesses types across the agricultural, small-scale manufacturing and service sectors. It is recognised that different types and scale of enterprise will have different energy needs, and will vary in their impacts on the communities within which they operate. However, given the issues regarding sample size discussed later in this section, it was not considered practicable to differentiate within this study between the impacts of electricity access on different types of enterprise, or between the poverty impacts of different kinds of enterprise achieving electricity access.

The statistical significance of the quantitative results varies by data type and because the effective sample sizes differ for each relationship or characteristic under examination. The quantitative results presented in this report may be classified into three types:

Type 1. Comparison of mean value for one subgroup among the sample with the mean value for another subgroup;

e.g. mean household income for beneficiaries in Community A compared to the mean household income for beneficiaries in Community B

Type 2. Comparison of the proportion of one subgroup that meets a certain criterion with the proportion of another subgroup that meets that criterion;

e.g. proportion of beneficiary enterprises that were created after the electricity access programme compared to the proportion of non-beneficiary enterprises that were created after the electricity access programme

Type 3. Correlation between two variables as recorded for each individual in the sample or a subgroup

e.g. correlation of productive use electricity access tier and enterprise profits within Community A

The field research in India involved surveys of some 260 households and enterprises. However, this sample size is significantly reduced when impacts are considered for subgroups of the overall sample. Some of the assessments were only valid when considered at the community (or community-pair) level because of differences between the programmes themselves and their social and economic contexts. In some cases data regarding a particular variable was only available for some of the respondents. For example, not all enterprises were in existence prior to the implementation of the electricity access programme in that community, and so the pre-programme level of electricity access could not be assessed. Likewise, not all households kept separate accounts for their household and productive activity's finances, meaning that impacts for them of the productive use of electricity could not be investigated. Much of the analysis compared beneficiary and non-beneficiary groups or beneficiary and non-beneficiary communities.

The statistical significances of results belonging to the first type (Type 1) were tested using the Students t-Test. Where differences in the mean values of certain indicators (from which possible causalities are inferred) are apparent, they do not always pass the test for 95% confidence. The lack of confidence can be attributed to small sample sizes (when working at a highly disaggregated level) but also to the large variation observed in most of the impact indicators. This level of variability was not anticipated at the research design stage. It is also possible that the true distributions for some of the indicators studied are significantly non-Gaussian, in which case the t-test confidence interval calculations would be invalid.

Results belonging to the second type (Type 2) were tested by calculating the standard error of the proportion. When the proportions differ by more than 1.96 standard errors, there can be 95% confidence that a true difference exists. Where apparent differences exist in the proportions of the subgroups that fulfil a certain criteria, the statistical significance tends to be better than for the differences between absolute values. Nevertheless, not all results pass the test for 95% confidence because of the relatively small size of the subgroups after disaggregation.

The statistical significance of the quantitative findings has been assessed throughout this work and indication given regarding the confidence that may be placed in apparent differences between two groups. Where the sample size and spread of the data result in a confidence of less than 95%, the data is marked in this report with the symbol ▲ and a footnote detailing the degree of confidence.

The statistical significance of the correlation coefficients was also tested. In general, the small number of data points for which the correlations could be calculated[22] meant that the confidence intervals on the correlations reported were typically rather broad. For this reason, in general only limited confidence can be placed on the stated strength of correlation (negligible/weak/moderate/strong).

[22] The number of data points for correlations was often significantly below the sample size for the determination of the variables alone because of the exclusion of certain respondents (e.g. those enterprises which did not exist prior to the electricity access programme).

3.2. RGGVY Grid Extension, Canning I, West Bengal [P1]

3.2.1. Description

Background

In April 2005, the government of India launched Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY) under the Ministry of Power (MoP). The nodal agency and programme implementer of the RGGVY is the Rural Electrification Corporation (REC) Limited, a Public Sector Enterprise established under the Ministry of Power. The RGGVY merged all other existing schemes of rural electrification such as 'Minimum Needs Program' and 'Accelerated Electrification of One lakh Villages and One Crore Households for rural electrification', with the goal of electrifying all un-electrified villages/ hamlets, providing access to electricity to all households and providing free connections to households below the national poverty line. The villages that come under the Remote Village Electrification Programme of Ministry of Non-conventional Sources (MNES) are kept out of the purview of RGGVY scheme for providing electricity[23] .

The scheme attempts to address some of the common issues with rural electrification in the country such as poor distribution networks, lack of maintenance, low load density with high transmission losses, rising costs of delivery, and poor quality of power supply. Beyond just village electrification, the emphasis of RGGVY has been to facilitate rural development, employment generation and poverty alleviation by providing access to electricity to all rural households, inclusive of below poverty line households and also to cater to the requirement of agriculture, small and micro enterprises, cold chains, health care, information technology and education.

Energy delivery model, including means and level of electricity access

As part of the RGGVY, the rural electrification plans are prepared by the state governments, through the designated agency for rural electrification, to assess in detail the means by which electricity is to be delivered i.e., either through grid extension or stand-alone systems to un-electrified households. These plans are then coordinated between state governments, state utilities and other agencies by the Rural Electrification Corporation (REC). At the central level, the Ministry of Power formulates rural electrification policies, sanctions projects, releases funds for project implementation through REC and also monitors the RGGVY's progress through a 3-tier quality-monitoring framework wherein, the first tier is the implementing agency in the State, the second tier is the REC and third tier is the Ministry of Power (MoP).

[23] http://rggvy.gov.in/rggvy/rggvyportal/rggvy_glance.html

Apart from the capital subsidy being provided by the Government, all the other funds for the programme are channelled through REC such as loan assistance on soft terms. Besides financing of the projects, REC establishes the framework for implementation involving formulation of technical specifications, procurement and bidding conditions, guidelines for project formulation, field appraisal & concurrent monitoring and evaluation to ensure quality and timely implementation. REC is responsible for complete oversight over the programme from concept to completion. Under RGGVY, services of Central Public Sector Undertakings (CPSUs) working in the power sector such as National Thermal Power Corporation (NTPC), National Hydro Power Corporation (NHPC), Power Grid Corporation India Limited (PGCIL) and Damodar Valley Corporation, have also been made available to States which were willing to utilise their services for implementation of the programme. After the installation, the village electricity infrastructure is handed over to the state electricity distribution utilities who then connect the households with service connections and start providing electricity.

As per the RGGVY scheme, the government provides finance to create the following means of rural electrification:

- A Rural Electricity Distribution Backbone (REDB) with 33/11 kV (or 66/11 kV) sub-station of adequate capacity in each block where it does not exists;
- Village Electrification Infrastructure (VEI) with provision of at least one distribution transformer in each village/habitation along with LT Lines / LT AB Cables;
- Decentralised Distributed Generation (DDG) systems based on conventional sources where grid supply is not feasible or cost-effective; and,
- Household connections to Below Poverty Line (BPL) and Above Poverty Line (APL) households

For all the above means, the central government provides 90% capital subsidy and soft loans for the remaining portion. The connections to Below Poverty Line (BPL) are given on 100% capital subsidy which includes electricity poles, service wire, meter, fuse, internal wiring and a bulb, whereas, the Above Poverty Line (APL) households have to approach distribution companies for connections.

Although the priority is to electrify villages through grid extension, in locations where grid connection is either not feasible or not cost-effective, stand-alone systems powered by renewable energy sources are considered as a viable option and are referred to as Decentralised Distributed Generation (DDG) systems under the RGGVY scheme. These systems are made grid-compatible to ensure that the investment in the DDG power plant is not sunk once the village receives grid connectivity.

As per our survey findings, RGGVY is providing more than 1.2 kWh/day covering 75 – 100% of people's requirements. Availability of electricity supply falls between 75 – 100% with more than 5 hours of unscheduled outages per month with moderate impact. Also, few issues in terms of quality are reported with moderate impact. In terms of enterprises, there are only slight or occasional reductions in terms of production or hours of operation resulting from energy unavailability and costs. The above evaluation is on the basis of certain attributes such as capacity, availability, reliability, quality and affordability. The rural electrification programme of RGGVY falls under Tier 3 as defined under the Multi-tier framework table by the World Bank.

Programme Scale and Costs

At the time of programme initiation, the programme cost was estimated to be INR 160 billion, out of which the subsidy amount was INR 147.5 billion and 1% of the total costs i.e. INR 1.6 billion was allotted to research, technology development, capacity building, information system development, awareness building, pilot studies and complimentary projects (Prayas, 2011).

According to the RGGVY Progress Report dated 31st July 2014, the total number of projects under combined phase 1 (X and XI Plan) and phase 2 (of XI plan) are 648 covering 579 number of districts. The funds released for this purpose were INR 322.34 billion in which the central government subsidy is INR 291.29 billion and contribution from state government is INR 31.05 billion. The achievements made in the electrification of villages and provision of free connections to BPL households are given in the table below:

Table 7: Projects Sanctioned and Achievements under RGGVY (Xth and XIth Plan and Phase 2 of XIth plan)

	Un-electrified villages	**Intensive electrification of villages**	**BPL households**
Projects Sanctioned	112,075	374,239	27,532,686
Achievement	108,573 (97%)	310,528 (83%)	21,871,956 (79%)

Estimation of capital subsidy for 12th and 13th plan is mentioned in the office memorandum of Ministry of Power dated 2nd September 2013 which states that for new projects, the estimated cost of electrifying habitations above 100 population is INR 0.9 million per household and the estimated cost of providing free connections to 30 million BPL households at INR 3000 per household. [24].

Impacts

Ministry of Power and REC authorises various agencies to undertake the task of evaluating RGGVY Reports. These evaluation reports[25] mention the impacts of the programme in different states along with their recommendations.

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[24] http://powermin.nic.in/whats_new/pdf/Continuation_RGGVY_12th&13th_Plan_Sept2013.pdf

[25] http://rggvy.gov.in/rggvy/rggvyportal/evaluation_reports.html

In various evaluation reports prepared by TERI[26], IRADe[27] and Sambodhi[28] some of the visible impacts of this programme are mentioned as follows:

- Increase in study time for students
- Better cooking environment and out-door safety
- Better facility and timing in health services and creation of employment opportunities in form of small commercial activities.
- Better opportunities in education, health, communication and economic development in the villages
- Facilitating implementation of National Electricity Policy and Rural Electrification Policy, strengthening rural electrification system through franchisees and,
- Opening up of opportunity for power generation from renewable energy resources and link it to the national grid

Factors facilitating/ constraining productive use of electricity access

During the field visit to one of the RGGVY site in West Bengal, it was found that consumers have complaints regarding load shedding (scheduled or unscheduled power outages) in the evening hours when the requirements is the greatest. Issue related to daily power cut for few hours and maintenance have also come up.

Key Lessons of the programme

In electrifying Indian rural landscape, RGGVY is an example of a significant effort in terms of planning, implementation and sustainable operation. While RGGVY has been very successful in connecting BPL rural household to the distribution network, it is recommended that mechanisms be developed to connect APL households with the grid at a similar level of efficiency. Since universal access is the target, a key driver for the RGGVY should be to increase the overall household connection level to both APL and BPL households. It is therefore essential that distribution companies initiate proactive connection drives (like the 100 x 100 drive) where all households within 100 meters of the power line are connected to ensure that all APL households also avail electricity connections. This would not only raise the APL household

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[26] The Energy and Resources Institute, commonly known as TERI, established in 1974, is a research institute based in New Delhi focusing its research activities in the fields of energy, environment and sustainable development.

[27] IRADe - Integrated Research for Action and Development, commonly known as IRADe, is a research institute based in New Delhi that focuses on energy, climate change, and the environment, with a goal of developing effective policies.

[28] Sambodhi is a management education provider and research institute.

connection numbers but would also help to reduce losses (due to illegal connections or theft), increase revenue and aid in better planning of distribution infrastructure.

The top down approach followed by RGGVY should also be analysed in greater depth as it has been suggested that central government should limit its role to the provision of capital subsidy and technical support for the states that must evolve their own strategies (Prayas, 2011). Also, RGGVY has focused on providing infrastructure overlooking the supply aspect of electricity in villages which needs greater attention.

As mentioned by Prayas in 2011, measures should be taken to ensure adequate good quality power supply especially during the evening hours. Considering the complaints regarding shortages, load shedding practices should be developed through participatory regulatory process in order to make load shedding transparent and predictable. Also, in order to make RGGVY network cater to productive loads, support should be given to States and Distribution Companies to augment the system to increase the coverage of such loads and RGGVY reports should be modified to include progress in catering to productive loads.

The creation of franchisees for the management of local power distribution in rural settings is reported to have introduced efficient billing and revenue collection, thereby ensuring stable delivery of electricity. TERI studies indicate that franchisees are particularly effective in the management of electricity provision and recovery because of their close contact with the targeted communities. Franchisee involvement has led to a stronger sense of ownership of the electrification process among the end-users.

Also, the three tier quality monitoring mechanism set up under the RGGVY is reported to be ensuring proper implementation of projects thereby contributing to their efficiency and long-term sustainability (Palit and Chaurey, 2011). RGGVY have followed standardised process and practices for implementing such a large scale rural electrification programme in terms of procurement, implementation and monitoring which has led to smooth operation of the programme and the same practices should be continued.

3.2.2. Community Selection

The households under the villages selected for central grid extension programme got access to electricity in the year 2010 whereas the market area got electricity access before households in the year 2007. In addition to the households, a large number of SMEs also exist in the village market for different activities, where electrification plays a positive role in enhancing business operations. While Basur Chak, Badukula, and Herobhanga are the beneficiary communities, the non-beneficiary community, Amtala, is located at a distance of about 2 kilometres from the beneficiary communities.

Table 8: Community Details - Rajiv Gandhi Grameen Vidyutikaran Yojana

Programme Name (P1)	RGGVY
Implementation Year	(For this site, the programme started in 2010 and 2007 for households and market respectively)
Location	Block: Canning I District: South 24 Parganas State: West Bengal

	Beneficiary	Non-beneficiary
Community Name(s)	Basur Chak Badukula Herobhanga[29]	Amtala
Number of households in community	Basurchak – 192 Badukula – 733 Herobhanga – 1401	639
Number of (registered) enterprises in community*	Registered - 132	Registered - Nil Unregistered - 5
Average household income per month before programme instituted*	3500 Rs.	2000 Rs.
Most recent available average household income per month*	5500 Rs.	3000 Rs.
Distance of community from nearest tarmac road	0 - 1 km (villages are connected with tarmac roads)	2.5 km
Distance of community from electricity grid	0 (grid connected)	2.5 km
Estimated time travel from community to block headquarter	40 minutes (14km)	1 hour (16.5 km)

[29] Most of the households surveyed are in villages, which fall on both side of the same village road. So while the households are spread over three villages, as per official records, all households are close to each other

* As per local self-governance body (Panchayat) records

3.2.3. Survey Analysis: Electricity Access and Impacts

Electricity Access Levels

The data derived from the surveys undertaken in the beneficiary and non-beneficiary community has been analysed, in line with the Global Tracking Framework to establish levels and changes in level of energy access. Table 9 shows the average electricity access tiers for the enterprises surveyed, and the average increase in electricity access tier since before the grid extension programme was implemented. Data is disaggregated to show the differences between *Beneficiary Respondents* (those enterprises which have received a grid connection under the programme) and *Non-Beneficiary Respondents*. The differences between beneficiaries and non-beneficiaries are statistically significant and are expected to prevail in the population at large. Table 10 disaggregates the enterprise electricity access levels by application, showing which applications are most frequently used and that the average application tier is for each.

Table 11 gives the same data about average tier and average increase in tier for household respondents (again, the difference between the two groups passes the test for statistical significance). Table 12 provides a count of the number of households which were assessed at each attribute tier for each of the six attributes of household electricity access.

Table 9: Enterprise Overall Electricity Access Levels, RGGVY

	Beneficiary Respondents	**Non-Beneficiary Respondents**	**Total**
Number surveyed	7	6	13
Average Electricity Access Tier	**1.8**	**0.2**	**1.1**
Number of enterprises for which change in electricity access tier can be calculated	5	0	5
Average Increase in Electricity Access Tier since Programme Implementation	**2.0**	**-**	**2.0**

Table 10: Enterprise Application Electricity Access Levels, RGGVY

			Beneficiary Respondents		Non-Beneficiary Respondents	
			Number of (Potential) Users[30]	Average Application Access Tier	Number of (Potential) Users	Average Application Access Tier
Application	tL	Lighting	7	1.86	6	0.17
	tI	ICT & Entertainment	1	2.00	0	-
	tM	Motive Power	2	2.00	1	1.00
	tS	Space Heating	0	-	0	-
	tP	Product Heating	0	-	0	-
	tW	Water Heating	0	-	0	-

Table 11: Household Electricity Access Levels, RGGVY

	Beneficiary Respondents	Non-Beneficiary Respondents	Total
Number surveyed	35	22	57
Average Electricity Access Tier	**1.5**	**0.0**	**0.9**
Number of households for which change in electricity access tier can be calculated	35	22	57
Average Increase in Electricity Access Tier since Programme Implementation	**1.5**	**0.0**	**0.9**

[30] Enterprises from that category (Beneficiary/Non-Beneficiary Respondents) either using electricity for this application, or reporting an unfulfilled need for energy to provide this application (which gives them Tier 0 access). An unfulfilled need means that the application is 'strictly necessary' for the productive activity, and that the business suffers from the lack of the application in terms of productivity, sales, costs and/or quality.

Table 12: Number of households assessed at each attribute tier, RGGVY

(Only includes those households with any electricity access)

			Attribute tier					
			0	1	2	3	4	5
Attribute	t1	Capacity		15	21			
	t2	Duration/Availability	1	11	1	23		
	t3	Reliability				35		1
	t4	Quality			19			17
	t5	Affordability		15				21
	t6	Legality			2			34

Of the six Non-Beneficiary Enterprises, only one had electricity access in the form of a fossil fuel-powered generator which was used to provide lighting and motive power for a sewing machine.

The seven Beneficiary Enterprises that were surveyed achieve an average tier of 1.8. Most use electricity only for lighting, but two manufacturing/processing enterprises also use motive power and one enterprise uses ICT to provide a photocopying service.

None of the household respondents who were not beneficiaries of the programme had any form of electricity access.

The level of electricity access provided to households under the RGGVY programme is assessed as being surprisingly low – about 1.5. 46% of the household beneficiaries received Tier 1 access, 51% Tier 2 access and the remainder Tier 0. The attribute that contributed most often to a low tier assessment was capacity, with three quarters reporting an electricity supply capacity of between 51W and 500W. The poor duration/availability of supply (typically less than 2 hours in the evenings) and the affordability of electricity were also frequent limiting factors. It is initially surprising that affordability of electricity is found to be a problem for grid connected households given the existence of subsidised 'lifeline' tariffs, but the framework used assesses the affordability of a standard consumption 'package' considerably higher than that used in practice in the case study community. Limits on expenditure are nevertheless likely to serve as constraints to a grid-connected household's increasing use of electricity even when that additional consumption offers significant benefits.

Electricity Access and Productive Uses

Table 13: Enterprise Electricity Access and Impacts, RGGVY

	Beneficiary Respondents	Non-Beneficiary Respondents	Total
Number surveyed	7	6	13
Impact: Creation of New Enterprises			
Number of Enterprises Surveyed Created Since Start of Programme	2	3	5
Impact: Enterprise Revenue			
Average Enterprise Monthly Revenue	24,429 ▲	30,167 ▲ [31]	27,077
Correlation Enterprise Monthly Revenue : Electricity Access Tier			22% (weak)
Change in Enterprise Monthly Revenue	No change reported among enterprises that existed pre-programme implementation		
Impact: Enterprise Profit			
Average Enterprise Monthly Profit	3,786 ▲	4,617 ▲ [32]	4,169
Correlation Enterprise Monthly Profit : Electricity Access Tier			21% (weak)
Change in Enterprise Monthly Profit	No change reported among enterprises that existed pre-programme implementation		

The 5 enterprises created since the start of the programme all belonged to the Beneficiary Community, indicating possible positive influence of improved electricity access (although this data could also indicate faster ‘turnover’ of enterprises within a more vibrant, or less stable, microeconomic environment). However, only two of these new enterprises had themselves received a grid connection.

The average revenues and profits for Non-Beneficiary Enterprises are higher than for Beneficiary Enterprises surveyed, although the small sample size and high variation between enterprises means that this result is not statistically significant regarding the wider community population. However, the average Non-Beneficiary Enterprise revenues and profits are skewed by the inclusion of one larger enterprise which employs 10 people and achieves revenues of Rs. 120,000/month. The data indicate very weak correlations between revenue and access tier and between profit and access.

[31] Very low confidence (<40%) that difference indicated in the sample exists in the wider population.

[32] Very low confidence (<40%) that difference exists in the population.

None of the enterprises surveyed were aware of any other development initiatives that had taken place in the community since the grid extension programme implementation.

Electricity Access and Poverty Impacts

Table 14: Household Electricity Access and Impacts, RGGVY

	Beneficiary Respondents	Non-Beneficiary Respondents	Total
Number surveyed	35	22	57
Impact: Household Income			
Average Monthly Household Income (Rs.)	5,289 ▲	4,136 ▲[33]	4,844
Correlation Monthly Income : Electricity Access Tier			25% (weak)
Average % Increase in Monthly HH Income	29% ▲	33% ▲[34]	31%
Correlation % Increase in Monthly Income: Increase in Electricity Access Tier			-9% (negligible)
% of those reporting increase in income who attribute it in whole or part to improved electricity access[35]	80%	0%	43%
Impact: Education			
% of HH with Children[36] Reporting Improvement in Education Available	54%	0%	33%
Correlation Increase in Electricity Access with Reported Improvement in Education			49% (moderate)
% of those reporting improvement in education who attribute it in whole or part to improved electricity access	63%	Zero respondents reported improvement	63%

[33] Medium confidence (82%) that difference indicated in the sample exists in the wider population.

[34] Low confidence (62%) that difference indicated in the sample exists in the wider population.

[35] Electricity access for the household or for the community

[36] In this community pair, all respondent households had children.

	Beneficiary Respondents	Non-Beneficiary Respondents	Total
Impact: Health			
% of HH Reporting Improvement in Health Care	6% ▲	0% ▲[37]	4%
Correlation Increase in Electricity Access with Reported Improvement in Health Care	Too few respondents reporting improvement		
% of those reporting improvement in health care who attribute it in whole or part to improved electricity access	Too few respondents reporting improvement		

The survey results display a significant difference in household income between Beneficiary and Non-Beneficiary Households, with those who had a mini-grid connection reporting incomes 28% higher. There is a very weak correlation between household income and electricity access tier.

Both groups saw roughly the same increase in household income since programme implementation. Correspondingly, the correlation between the change in income and the change in electricity access tier is negligible. Nevertheless, 80% of beneficiaries attributed the increase in their income at least in part to improved electricity access (either for the household or for the wider community).

More than half the Beneficiary Households reported an improvement in the education available for their children, compared to none of the non-Beneficiaries. Of those reporting an improvement in education, almost two-thirds attributed it in whole or in part to improved electricity access.

Very few respondents reported an improvement in health care.

Less than a fifth of Beneficiary respondents identified any other development initiatives besides the grid extension programme that could have had an impact on their incomes, education or health care. The other initiatives identified concerned new or upgraded roads, schools, markets and street lighting. Some of the respondents thought that these initiatives had encouraged them to take up electricity access, whereas others felt that they were not significantly relevant to their decision.

3.2.4. Community Feedback Workshop/Focus Group Report

A focus group discussion was held with the community members from Herobhanga village of Gopalpur Gram Panchayat, Canning I Block, South 24 Parganas, West Bengal where the survey had taken place. About 15 persons, representing the households and SMEs, participated in the discussion that took place on 13th August 2014 at the meeting hall of Gopalpur Gram Panchayet office.

[37] Good confidence (85%) that difference exists in population, but 95% confidence threshold not achieved.

Findings from the survey

The main findings from survey are as follows, which were validated by the community members during the discussion:

a) Households are metered.
b) There is no restriction on using any kind of electrical appliances.
c) The electricity provided comes with a provisioning of 24 hours of supply.
d) The main issues faced by the villagers in terms of the electricity provided to them are:

   - Although people are using electricity for the productive purposes but most of the time they face unscheduled power interruptions. Sometimes the power cut happens for 3-4 hours continuously and that too more than one time in a day. Besides the power cut, people are also facing low voltage problems mainly during the evening time.
   - There is a frequent problem of very low voltage during the evening hours which do not allow users even to light a 15Wp CFL lamp.
   - During the summer season they face several power cuts.
   - Also, the distribution company takes time to maintain the faults of the distribution line and machineries.

Energy requirements of the community

The villagers require a better voltage facility especially during the evening hours so that they can perform their house hold chores with ease and the children can study as well. Some of the households in the community are engaged with productive activities such as artisan work and tailoring which demands reliable and good quality supply of electricity. People were also of the view that there is a requirement of better service delivery and efficient maintenance work from the distribution company.


Figure 7: Village members expressing their views during the focus group discussion, RGGVY

Problems faced by the current mode of electricity

The major problem reported by the households is extremely poor service delivery from the distribution company as they usually take more than two days to address and rectify the faults.

Suggestions for better service

The participants of the discussion gave a few suggestions for better provision of service. These are as follows:

a) A facility for providing better quality of electricity as per the demand of the villagers should be made, such that it may be used for productive activities in the household level as well.
b) The supply of the electricity should be better quality and interruption free.
c) The faults and problems of the distribution line and machineries must be taken care of by the distribution company.

3.3. Husk Power Systems, Madhuban, Bihar [P2]

3.3.1. Description

Background

Husk Power Systems (HPS) provides decentralised renewable energy to non-electrified rural households and also to micro-enterprises or other business establishments in the village. The programme was launched on 15 August 2007 in Champaran district of Bihar. Six plants based on the technology of Biomass Gasification were in operation by the year 2009. The plant size ranged between 30kWe – 100kWe (IFMR, 2011). The key objective of the programme is lighting households in villages containing more than 1000 houses and a minimum of 250 houses ready to take supply.

HPS founding partners Ratnesh Yadav and Gyanesh Pandey wanted to combine low cost electricity supply with high quality service to create a viable business model in the field of rural electricity. This aspiration for developing a viable, small-scale electricity generation option led them to a local resource, husk, abundantly found in the rice-growing regions of the country and which was previously treated as a waste. This husk can be procured at very low cost for conversion to electricity. Initial funding source was the prize money won at technology and business concept competition held in the US and the personal savings of the founding partners.

Energy delivery model, including means and level of electricity access

HPS collaborated with local manufacturers to produce the gasifiers for their plants which use rice husk as a raw material. Thus, power plants are installed in places where there are reliable sources of rice husk and other biomass residues within a distance of 10 km (Ashden, 2011). Biomass gasification technology involves loading the biomass (rice husk or other biomass residues) into the gasifier hopper every 30 to 45 minutes. The burning of biomass in a restricted supply of air produces energy-rich producer gas which passes through a series of filters which clean the gas, which is then used as the fuel for an engine that drives the electricity generator. This electricity is distributed via insulated overhead cables connected to homes and small businesses that have signed up for connections (Ashden, 2011).

To set up a new plant, a village or local authority submits a receipt of request to avail HPS service and an initial deposit is taken by HPS from the interested consumers to cover up to three months of the cost of electricity. Once a suitable number of consumers have expressed interest, the feasibility of a biomass-based plant is undertaken to ensure a secure source of fuel supply for the plant. This is followed by site selection which is often in the niche areas where HPS can displace diesel-based generation by offering electricity at a cheaper rate. Installation, then takes about a month and a local team is set up to operate the system on a daily basis. The electricity supply generally ranges from 6-7 hours for a fixed period of time providing a basic level of lighting service through two CFLs and a mobile charging point for which a consumer has to pay a connection charge and a flat monthly fee varying from 150 – 200 INR. There is also an option for customised packages. Depending on the willingness of consumers and the village size, a typical plant is capable of serving 4 villages with around 400 consumers within a radius of 1.5 kilometres of the plant. Also, small commercial enterprises can avail the electricity access by paying a higher flat rate (Bhattacharya, 2014).

The pilot model was implemented by HPS following Built, Owned, Operated and Maintained by HPS (BOOM) model. After the effective implementation of this model at the pilot stage, HPS brought in two more business model namely – BOM model: Built, Owned and Maintained by HPS but operated by a local partner and, BM model: Built and Maintained by HPS but owned and operated by local entrepreneur.

In the BOOM model, the entire business chain is looked after by the company resulting in the growing need of a dedicated set of staff to operate and maintain new plants. In this model, the overheads are high. In the BOM model, HPS maintains the plant and gets a rental fee whereas the operational aspects of the system are looked after by the entrepreneur who also shares the business by making a small contribution to capital (about 10%).This reduces some of the management duties for HPS and helps in building a local network of entrepreneurs. After a specified period of time, upon recovering the cost of investment, the company transfers the ownership. However, verifying the quality of service delivery by the local entrepreneur is difficult and the speed of replication using this approach remains unclear. Lastly, the Build and Maintain (BM) model limits the role of HPS to supply the technology for a fee and maintaining the plant through a maintenance contract and the business is run by a local entrepreneur who uses the HPS brand for the supply. This is also called as HPS franchisee model in which the business can scale up as long as the franchisee is able to finance the investment and is capable of running it effectively (Bhattacharya, 2014).

As per our survey findings, HPS is providing 1W – 50W covering partial needs of people. More than 5 hours of unscheduled outages per month of little impact are reported along with quality issues of moderate impact. There are only slight or occasional disruptions in operating hours due to outages. As per this evaluation, many of the attributes for the HPS technology are falling under Tier 3 and Tier 4 as defined under the Multi-tier framework by the World Bank but the HPS programme on a whole would be Tier 1 owing the supply of power being in the range of 1 to 50 W.

Programme Scale and Costs

Since the programme inception, HPS has installed 84 mini-power plants in a period of four years thereby providing electricity to over 200,000 people spread across 300 villages[38] over six districts in Bihar. The total capital cost for a typical 32kW Husk Power Plant is INR 2.0 million (including subsidy, wire cost, maintenance and training costs) and each plant serves about 400 households.

[38] http://www.huskpowersystems.com/innerPage.php?pageT=Community Impact&page_id=81

In order to lower the production and establishment costs of the programme, HPS has reduced the plant construction costs by constructing houses of bamboo instead of concrete and putting bamboo poles for carrying transmission lines. This enabled HPS to come out with a competitive pricing strategy which helped households in procuring the service at a very reasonable rate.

Impacts

A typical poor family before using HPS electricity was not only spending more on kerosene but was also facing problems like burglaries due to absence of proper lighting at night, risk of fire due to exposure of smoke and fumes from kerosene lamps, poor lighting conditions for studying, snakebites, and difficulty in doing household chores. Also, the un-availability of proper light during evening hours prohibited people from leaving their shops open for longer hours or from starting revenue generating activity. After the users started availing the services from HPS, there have been a number of visible positive impacts mentioned as follows:

- Increase in mobile phone ownership from 10% to 80% of households in one village as people had to travel long distances to get their phones charged.
- About one third of savings on electricity per month when compared to monthly expenditure spent on kerosene/diesel earlier.
- According to Ashden Awards report on HPS, households stop using kerosene lamps when they got HPS electricity thus saving 6 - 7 litres/month of kerosene on average. Thus, amounting to 2.7 million litres per year of kerosene saving for 32,500 households supplied at the end of March 2011.
- Generated new businesses like photocopying shops, tailoring and grocery store at local level and also allowed established micro enterprises such as general store, repair, barber shop etc. to work for longer hours after sunset. HPS created good employment in form of local labourers required for plant assembly and four more employee positions for plant operator, electrician, husk loader and fee collector.
- Women working part-time making incense sticks from risk husk char produced as a by-product of the gasification process. As per the Ashden report, groups of about 15 women working at five plants can earn about INR 80 per day.

This potential income generation opportunity of incense stick making by the char obtained from burning the husk where local women are employed is reported to produce 6 ton of incense sticks in a year from a 32kW plant (Bhattacharya, 2014). This inherent characteristic of the technology which is put well by HPS to use by local community is an enabling factor for productive use of electricity access. It should be noted however that the machinery for grinding the char into a paste for production of incense sticks is operated on diesel gensets.

Factors facilitating/ constraining productive use of electricity access

Since, the Husk Power system is typically designed to provide lighting to rural areas and the capacity provided is low, ranging from 30W-100W (but primarily in the 30 W range), therefore it limits the ability to add income-generating loads to the system. There are a few other factors which impede users from taking up electricity access from HPS for productive uses. For example, HPS as a model is still not open to developing straightforward deals with commercial investors or lenders and are still in the phase where their micro-franchise model needs to be refined to scale up effectively. There are also constraints faced in terms of securing capital required to develop its franchise approach because banks are not willing to take the risk with an early-stage venture (IFC, 2012).

The company target of electrifying 10 million people by 2017 (Bhattacharya, 2014) requires a rapid replication of activities which largely depends on how the business models work. For this level of scalability, HPS needs to work on financial resources, management capabilities, skilled local staff, adequate manufacturing capabilities and especially the energy resources as the availability of husk in all areas can be a big issue if husk finds an alternative use.

Key Lessons of the programme

In terms of scaling, the franchise model i.e., the BM model with separate responsibilities of building/maintenance and operating is more scalable than the BOOM model of maintaining and operating the system on its own. Here, the franchisee is able to apply through locally available schemes like Credit Guarantee Scheme for Micro and Small Enterprises (CGMSE) or raise funds among local banks in line with the investor’s need. For a successful replication, one needs to have a very clear understanding of the local market and make use of the locally available resources or circumstances in order to adapt the different aspects of the model effectively.

There is always uncertainty on the information regarding when the un-electrified site being served by off-grid electricity programme will come under the grid extension which causes high risks for the companies. In such a scenario, the government should take the responsibility of absorbing the systems operating on off-grid energy to the grid in case the grid extends to these areas.

Companies working with solar can apply for a direct subsidy from central government under the National Solar Mission whereas the subsidies for biomass programmes are channelled through the state government which leads to longer administrative process and higher transaction costs for the companies. Though in the case of HPS, the subsidy was channelled directly by the central government which enabled HPS to access the subsidy much faster and under less bureaucratic processes than other companies.

In extremely poor and rural areas, the ability to pay off the local community is much lower. So, in such a state, an additional cross-subsidy from the government is required to ensure operational viability of the installed systems.

3.3.2. Community Selection

As mentioned in the previous section on Review of Programmes, Husk Power Systems have installed biomass gasifier power plants in over 300 villages in Bihar.

The village Tamkuha was selected as it was electrified from the HPS systems around 5 years back for the first time and on the basis of its large sample size of the households connected to HPS power plants. Further, there is also presence of a non-beneficiary community that is, Pachkaria, which is completely un-electrified, in the vicinity of the beneficiary village. These sites also have a thriving market place which has reportedly grown since the arrival of the mini-grid and serves as an ideal location to conduct surveys with SMEs. As there were no shops in the non-beneficiary community of Pachkaria due to its close proximity to beneficiary communities, therefore the SMEs to be surveyed under the category of non-beneficiary SME in non-beneficiary community were selected from beneficiary community only. The households in this region got access to electricity during the period from 2007 to 2010, thus, enhancing the possibility of impacts from electrification.

Table 15: Community Details – Husk Power Systems

Programme Name (P2)	**Husk Power Systems**
Implementation Year	Launched as a pilot in Tamkuha in August 2007
Location	Block: Madhuban District: West Champaran State: Bihar

	Beneficiary	**Non-beneficiary**[39]
Community Name(s)	Tamkuha (main village) Dhawa (hamlet) Khualapati (hamlet)	Pachkaria (hamlet)
Number of households in community	1500[40]	
Number of (registered) enterprises in community*	Registered: None Unregistered: 60-70[41]	

[39] Non-Beneficiary households were surveyed in Beneficiary village because there was no completely un-electrified community/village in the vicinity.

[40] This is the total number of households for village Tamkuha which includes Dhawa, Khualapati, Pachkaria as these hamlets come under Tamkuha only.

[41] This approx. range for existing enterprises are for Tamkuha as well as other hamlets (Dhawa, Khualapati and Pachkaria)

* As per local self-governance body (Panchayat) records

	Beneficiary	Non-beneficiary[39]
Average household income per month before programme instituted*	4500 Rs.	3500 Rs.
Most recent available average household income per month*	6000 Rs.	5000 Rs.
Distance of community from nearest tarmac road	0 - 1 km (villages are connected with tarmac roads)	0 - 1 km (villages are connected with tarmac roads)
Distance of community from electricity grid	Approx. 8 km	Approx. 8 km
Estimated time travel from community to block headquarter	40 minutes (13km)	40 minutes (13km)

3.3.3. Survey Analysis: Electricity Access and Impacts

Electricity Access Levels

As per the previous section, the survey data has been analysed in line with the Global Tracking Framework to establish levels and changes in level of energy access. Table 16 shows the average electricity access tiers for the enterprises surveyed, and the average increase in electricity access tier since before the mini-grid programme was implemented. Data is disaggregated to show the differences between *Beneficiary Respondents* and *Non-Beneficiary Respondents*. Table 17 disaggregates the enterprise electricity access levels by application, showing which applications are most frequently used and that the average application tier is for each.

Table 18 gives the same data about average tier and average increase in tier for household respondents. Table 19 provides a count of the number of households which were assessed at each attribute tier for each of the six attributes of household electricity access.

Table 16: Enterprise Overall Electricity Access Levels, HPS

	Beneficiary Respondents	Non-Beneficiary Respondents	Total
Number surveyed	5	5	10
Average Electricity Access Tier	**0.7**	**0.0**	**0.4**
Number of enterprises for which change in electricity access tier can be calculated	3	0	3
Average Increase in Electricity Access Tier since Programme Implementation	**0.5**	**-**	**0.5**

Table 17: Enterprise Application Electricity Access Levels, HPS

			Beneficiary Respondents		Non-Beneficiary Respondents	
			Number of (Potential) Users[42]	Average Application Access Tier	Number of (Potential) Users	Average Application Access Tier
Application	**tL**	**Lighting**	5	0.80	4	0.00
	tI	**ICT & Entertainment**	0	-	0	-
	tM	**Motive Power**	1	0.00	0	-
	tS	**Space Heating**	0	-	0	-
	tP	**Product Heating**	0	-	0	-
	tW	**Water Heating**	0	-	0	-

Table 18: Household Electricity Access Levels, HPS

	Beneficiary Respondents	Non-Beneficiary Respondents	Total
Number surveyed	30	21	51
Average Electricity Access Tier	**0.9**	**0.0**	**0.5**
Number of households for which change in electricity access tier can be calculated	30	20	50
Average Increase in Electricity Access Tier since Programme Implementation	**0.8**	**0.0**	**0.5**

[42] Enterprises from that category (Beneficiary/Non-Beneficiary Respondents) either using electricity for this application, or reporting an unfulfilled need for energy to provide this application (which gives them Tier 0 access). An unfulfilled need means that the application is 'strictly necessary' for the productive activity, and that the business suffers from the lack of the application in terms of productivity, sales, costs and/or quality.

Table 19: Number of households assessed at each attribute tier, HPS

(Only includes those households with some electricity access)

			Attribute tier					
			0	1	2	3	4	5
Attribute	t1	Capacity	1	31				
	t2	Duration/Availability	6		26			
	t3	Reliability				18		11
	t4	Quality			10			21
	t5	Affordability		31				
	t6	Legality			1			31

None of the five Non-Beneficiary Enterprises had any form of electricity access.

The five Beneficiary Enterprises that were surveyed achieve an average tier of 0.8. All but one of the enterprises reported that, of the six applications, only lighting was relevant to their productive activity. One enterprise (a hairdresser/barber) has a need for motive power[43] but does not regularly use it, so is assessed as having Tier 0 access for this application. The lighting users all achieved either Tier 0 or Tier 1 access for this application.

None of the household respondents who were not beneficiaries of the programme had any form of electricity access, except for one user of small, non-rechargeable batteries.

The average level of electricity access provided to households under the HPS programme is assessed as being 0.9. 13% of the household beneficiaries received Tier 0 access and the other 87% Tier 1 access. The attributes that contributed most often to a low tier assessment were capacity and affordability, with all but one reporting an electricity supply capacity of between 1W and 50W and the cost of a 1 kWh/day energy consumption typically well beyond 10% of household income. The poor duration/availability of supply (less than 8 hours per day) was sometimes also a limiting factor.

[43] Reports that motive power is ‘strictly necessary’ for the productive activity, and that the business suffers from the lack of motive power in terms of productivity, sales and quality.

Electricity Access and Productive Uses

Table 20: Enterprise Electricity Access and Impacts, HPS

	Beneficiary Respondents	Non-Beneficiary Respondents	Total
Number surveyed	5	5	10
Impact: Creation of New Enterprises Number of Enterprises Surveyed Created Since Start of Programme	2	2	4
Impact: Enterprise Revenue			
Average Enterprise Monthly Revenue	10,400 ▲	15,600 ▲[44]	13,000
Correlation Enterprise Monthly Revenue : Electricity Access Tier			-17% (negligible)
% Change in Enterprise Monthly Revenue	50% ▲	100% ▲[45]	75%
Correlation % Change in Enterprise Monthly Revenue : Change in Electricity Access Tier	Too few respondents reporting improvement		
Impact: Enterprise Profit			
Average Enterprise Monthly Profit	2,250	2,200	2,225
Correlation Enterprise Monthly Profit : Electricity Access Tier			-[46]
Change in Enterprise Monthly Profit	48% ▲	33% ▲[47]	40%
Correlation % Change in Enterprise Monthly Revenue : Change in Electricity Access Tier	Too few respondents reporting improvement		

Of the surveyed enterprises, two Beneficiary and two Non-Beneficiary enterprises were created since the start of the programme.

The average revenues for Non-Beneficiary Enterprise respondents are higher than for Beneficiary Enterprise respondents. As for the RGGVY programme, the average Non-Beneficiary Enterprise revenue is skewed by the inclusion of one ‘outlier’, a grocery store which achieves revenues of Rs. 60,000/month (surpassing all other surveyed enterprises by a factor of four). There is no meaningful correlation between revenue and access tier.

[44] Very low confidence (<40%) that difference exists in the population.

[45] Medium confidence (84%) that difference exists in the population.

[46] No correlation possible – too few data points (only 3 enterprises saw a change in electricity access)

[47] Very low confidence (<40%) that difference exists in the population.

There is no difference in enterprise profits between the Beneficiary and Non-Beneficiary groups, although the Beneficiary enterprises saw a slightly larger increase in profits since programme implementation (48% vs. 33%).

All Beneficiary Enterprises reporting a change in revenue or profits attributed this in whole or in part to improved electricity access for the business or the wider community.

One enterprise identified a hospital as another development initiative that had taken place in the community since the implementation of the mini-grid, but said that this had not at all influenced the enterprise's decision to take up electricity access.

Electricity Access and Poverty Impacts

Table 21: Household Electricity Access and Impacts, HPS

	Beneficiary Respondents	Non-Beneficiary Respondents	Total
Number surveyed	30	21	51
Impact: Household Income			
Average Monthly Household Income (Rs.)	6,060 ▲	5,600 ▲[48]	5,872
Correlation Monthly Income : Electricity Access Tier			14% (negligible)
Average % Increase in Monthly HH Income	23% ▲	56% ▲[49]	37%
Correlation % Increase in Monthly Income: Increase in Electricity Access Tier			-17% (negligible)
% of those reporting increase in income who attribute it in whole or part to improved electricity access[50]	25%	0%	18%
Impact: Education			
% of HH with Children[51] Reporting Improvement in Education Available	47%	10%	31%
Correlation Increase in Electricity Access with Reported Improvement in Education			26% (weak)
% of those reporting improvement in education who attribute it in whole or part to improved electricity access[52]	71%	0%	63%

[48] Very low confidence (<40%) that difference exists in the population.

[49] Good confidence (92%) that difference exists in population, but 95% confidence threshold not achieved.

[50] Electricity access for the household or for the community

[51] In this community pair, all but one respondent household had children.

	Beneficiary Respondents	Non-Beneficiary Respondents	Total
Impact: Health			
% of HH Reporting Improvement in Health Care	40%	0%	24%
Correlation Increase in Electricity Access with Reported Improvement in Health Care			47% (moderate)
% of those reporting improvement in health care who attribute it in whole or part to improved electricity access	100%	0%	100%

Again, Beneficiary Households under the Husk Power programme tended to have slightly higher household incomes than non-beneficiaries. However, the relationship between income and electricity access level is not strong enough to produce a correlation.

Non-Beneficiary Households enjoyed a higher % increase in income (56%) compared with beneficiaries (23%). The lack of a correlation between change in income and change in access tier is supported by the fact that only a quarter of beneficiaries reporting an increase in income attribute it to improved electricity access.

Rather more Beneficiary than Non-Beneficiary Households reported an improvement in education (47% versus 10%) – a weak correlation with electricity access tier. Of those reporting education improvements, 71% of beneficiaries, but nil non-beneficiaries, attributed the improvements to increased electricity access for themselves or their community.

A similar pattern is found for health care, with 40% of beneficiaries, but nil non-beneficiaries, reporting an improvement. This gave a moderate correlation with electricity access tier, supported by the fact that all beneficiaries who had seen an improvement in healthcare attributed it, at least in part, to improved electricity access.

Respondents across both Beneficiary and Non-Beneficiary groups reported some of the other development initiatives that have taken place since the HPS programme implementation. A school and a health centre were most commonly stated, and a new bridge was mentioned. None of the respondents felt that the other development initiatives had affected their decision whether or not to take up improved electricity access.

3.3.4. Community Feedback Workshop/Focus Group Report

The focus group discussion was held with about 12 participants belonging to Tamkuha village and its hamlets on 22nd July, 2014 at the village community centre.

[52] Electricity access for the household or for the community

Findings from the survey

The main findings from survey are as follows, which were validated by the community members during the discussion:

a) Each household is provided with two light points and a mobile charging point at a monthly tariff of INR150. Each light point is of 15W.
b) Electricity is provided for 4 to 6 hours, between 6pm to 12 midnight.
c) The main issues faced by the villagers in terms of the electricity provided to them are low capacity of the electricity supply (because of which the shop keepers cannot use it for productive loads) and the number of hours of disruption to the electricity supply. The households often experience power cuts without prior information, which lead to interruption in performing household chores. Also, during the monsoon season they face power cuts because of issues in the service lines.

Figure 8: Village members expressing their views during the focus group discussion, HPS

Energy requirements of the community

Many of the villagers reported problems of light flickering and dim light on a frequent basis and therefore the villagers felt the need for a service that can provide better voltage facility. Some of them also expressed the wish to have a supply that can be used for productive purposes to carry out the tasks of grinding, blacksmith, mobile repairing and hair drying at a barber shop. Villagers were of the view that there should be a reliable supply of electricity as the current energy supply does not meet the HPS promise of supplying 6 hours of quality supply. They also desire for a better quality of electricity which could be used in institutions such as schools so that children can learn about computers.

Problems faced by the current mode of electricity

The villagers residing near the plant have access to better service in terms of quality of electricity whereas households which are beyond 900metres reported complaints regarding bad quality of electricity supply. This may be due to losses in transmitting electricity to households that are far off. The bamboo structures that are holding up the transmission wires could not withstand during storm conditions. In some cases the HPS team did not address the faults in the service line within a short period of time and the villagers had to wait for several days before the problem was rectified.

Suggestions for better service

The participants of the discussion gave a few suggestions for better provision of service. These are as follows:

a) A facility for providing electricity as per the demand of individuals should be made, such that it may be used for productive loads as well. The villagers expressed their readiness to pay more for such service.
b) The duration of hours for which the electricity was provided should increase, and it must be provided during the day time also for those who require it for running their enterprise (e.g., barber shop). Currently, the electricity service is only during the evening hours.
c) The infrastructure used for transmission lines must be made stronger to withstand all weather conditions, such that the villagers do not face many interruptions.
d) The customers must not be charged for electricity if the faults reported by them take more than 3 days to be rectified.

Figure 9: Participants representing households and enterprises during the discussion, HPS

3.4. Lighting a Billion Lives, Thakurmunda, Orissa [P3]

3.4.1. Description

Background

Economically poor rural communities that either do not have electricity supply or suffer from erratic and insufficient supply still have to resort to the use of environmentally unsustainable fuel such as kerosene for meeting their lighting needs. Lighting a Billion Lives (LaBL) is one such initiative by The Energy Resources Institute (TERI) towards providing sustainable energy to these rural communities. In India, 61 million rural households have no access to electricity and use kerosene for lighting which amounts to 2.2 billion litres per year of kerosene to be burned for lighting. In response to this unfortunate state, LaBL is an initiative that enables people to get clean and adequate light at an affordable cost.

Energy delivery model, including means and level of electricity access

The LaBL programme uses an entrepreneur-based model for energy service delivery, providing solar lanterns through micro solar enterprises set-up in un-electrified or poorly electrified villages. The local entrepreneur operating and managing these enterprises is trained by TERI and rents out the solar lamps every evening for a nominal fee. Two alternative financing models are used by LaBL's distribution programme:

- a **fee for service model** in which a large share of capital costs are supported through grants and the beneficiaries access solar lanterns by paying only a nominal rental charge on a daily basis
- a **loan finance model** in which an entrepreneur can start a solar enterprise by making use of loans offered by financial institutions, with a portion of the ongoing costs of the enterprise being covered by subsidy through the LaBL partner organisations (including government agencies).

LaBL began its operation with the promotion of *Solar Charging Stations (SCS)*, community-level lighting solutions making use of mobile lantern technology. One SCS usually consists of 50 lanterns, 5 solar panels and 5 junction boxes. A lantern provides light from a 2 W LED lamp for 4-6 hours. These lanterns are provided to households and enterprises each evening on a rental basis, with the charge varying between INR 2 and INR 5 per day per lantern. Though LaBL started its operation with SCS technology, over the years it has developed various other energy access delivery solutions aiming to light up households in rural communities with solar energy. Such other lighting models under LaBL are:

- *Solar Micro Grids* through which low voltage electricity is distributed over a short distance from the battery banks for 4-5 hours each night to power the household/shop lights. In order to reduce per connection power consumption, LED lights are utilised.

- *Solar Home Light Systems (SHLS)* that gives an individual ownership of the lighting system and autonomy over its operation. Each system provides a household with two light points and a point for mobile charging, powered by a solar panel and a lead acid battery with a 2 year warranty. In some places, these solar home light systems are being integrated with improved cookstoves and are called *Integrated Domestic Energy Systems (IDES)*.

The main focus of the LaBL programme is to provide basic electricity connectivity to villages. It is assumed that once people have this basic access, they will put it to productive use to at least some degree without further assistance. Recently, TERI has developed *Solar Multi Utility Units* which have the capacity to support some higher-power productive loads so that village-level micro enterprises (such as spice grinding units, rice/wheat mills and artisan cottage industries) can run on a clean, reliable and affordable source of energy supply. However, this initiative has deliberately been excluded from the scope of this study, which focuses on the standalone lighting component of the LaBL programme.

According to the World Bank's Multi-tier Global Tracking Framework, the energy access provided through the LaBL programme might put beneficiaries at Tier 3/Tier 4 for some of the attributes (such as availability, reliability and quality) but overall the energy access level provided under its various models would be Tier 1 because the capacity of each end-user supply is less than 50W.

Programme Scale and Costs

Recent data show that the programme has reached 2,549 villages impacting over 2.3 million rural lives in India. The extent of LaBL is not just restricted to India but has reached beyond the country borders to more than 10 other countries where 123 Solar Charging Stations are in operation. In all, 127,080 solar lanterns have been disseminated, 10,580 households have solar micro grid connections and 7,440 SHS and IDES are in operation. Delivery at this scale involves an efficient network of 34 Technical Partners, 114 Partner Organisations and 131 energy enterprises.

Impacts

The regions where LaBL has reached faced similar problems prior to programme implementation. The cost of the kerosene affected household budgets to a great extent. People not only had to buy extra kerosene above the government allotted quantity from private dealers at very high prices but also had to travel long distances to get that fuel. Also, not being able to do household chores in the dark and the need to travel to shops to charge cell phones for 5 to 10 INR per day presented major setbacks. Safety concerns abounded, from house fires to health problems caused by kerosene smoke. Due to the unavailability of proper light, people could not open their shops after sunset thus affecting their ability to earn. School going children were not interested in studying under the kerosene light.

These scenarios of social and economic deprivation changed noticeably after the advent of solar lighting provided through the various models of LaBL programme. LaBL's solar products have not only augmented access to modern lighting but have provided users with a range of co-benefits such as increases in children's' study hours and helping households to deter animals from approaching human settlements which effectively limits prospects of human-wildlife conflict. Similarly, health workers and midwives use the solar lanterns to deliver medical aid after daylight hours. There is a direct livelihoods benefit in the form of 'green jobs' for the entrepreneurs managing the SCS and earning through renting. The impact study done during the period of August 2008 to April 2010 for 121 Solar charging Stations (SCS) found that SCS operators (mostly women) earn approximately INR 1500 – 3500 per month by renting out lanterns. This role and earning has boosted a sense of empowerment. Furthermore, the average monthly income of the entrepreneurs managing the SCS was found to be INR 1609 with some charging stations recording as high as INR 5000 per month. Many of the communities are using this lighting to enhance their business hours post sunset for activities like betel leaf farming in West Bengal, eco-tourism in tribal areas of Orissa, basket making in Rajasthan, and bamboo craft in Assam, amongst others (Palit and Singh, 2011).

TERI's internal impact study reports for the solar home lighting system operating in the district of Purnia, Bihar have shown that all users are satisfied with the brightness of the light and happy with the reliability and control they have over their lighting as compared with grid electricity supply which is highly erratic. The school-going children are studying more by solar light (more than 2 hours per day) rather than at most an hour by kerosene lantern light. The solar light has also helped in the creation of small income generating activities such as sewing, vending, shop keeping, tuition centres and other village level services. The impact report also shows reduction in health-damaging effects such as blackened nostrils, red eyes, coughing and watery eyes which were previously observed during the usage of kerosene as a lighting fuel.

Factors facilitating/ constraining productive use of electricity access

In terms of scalability, the LaBL programme is financially, technologically and operationally replicable. TERI energy access models focus on basic lighting and thus cater to those income generating activities that are do not require power beyond lighting, such as weaving, tailoring, leaf plate making etc. In general, the LaBL systems are not capable of supporting mechanised loads. Though the priority is to light rural households, programme partner TERI lists factors that could enable productive use of electricity access as reliable electricity supply, access to finance and training for skill building. TERI believes that the biggest constraints in areas where people have already put electricity to some use are the reliability and availability of electricity supply.

Key Lessons of the programme

LaBL addresses issues pertaining to electricity access by adopting a localised, bottom-up approach where an energy-starved population can benefit from clean lighting. Some of the key lessons of the programme are as follows:

- LaBL developed a partnership base of three tier institutional arrangements involving strategic partners: government bodies and international bilateral/multilateral agencies at the 'macro' level of the partnership network, local NGOs and other implementing agencies at the 'meso' level and the institution of Energy Enterprises to enable post-implementation maintenance support to ensure sustainability at the 'micro' level.

- LaBL has been able to develop convergence with other developmental programmes in providing co-benefits to rural communities. LaBL linked with micro-finance institutions and livelihood development programmes to promote innovative financing models, while it also leveraged local developmental funds from government agencies to extend clean lighting to BOP communities.
- LaBL programme has been able to leverage strong partnerships at different levels such as partnerships with technology providers to innovate newer designs of solar lamps; partnerships with national and local financial institutions to support the implementation; and most importantly, partnerships with the grassroot partner organisations to expand the programme for last mile delivery and also ensure replicability.
- Improvement and development of programme implementation through participatory monitoring-evaluation and continued feedback-experience gained for leading towards project sustainability.

3.4.2. Community Selection

Stand-alone system programmes in India are often implemented in villages which are either very remote (where extension of the central grid may be economically daunting) or are only partially electrified (with the central grid often providing only a low quantity and poor quality of power). As part of the LaBL programme, TERI has implemented solar lantern charging stations in around 2500 villages across 22 states in India that cover both of these categories. The village Jambani, in the state of Odisha, was completely un-electrified before the LaBL charging station was installed in the village in 2010. The non-beneficiary community of Nekedabasa is located in the vicinity of the beneficiary community. Practically, the residents of Jambani and Nekedabasa have no other options for lighting beyond the use of fuel-based lighting sources like kerosene, and the villages have been informed that grid extension is not feasible because of their remoteness.

Table 22: Community data, LaBL

Programme Name (P3)	**Lighting a Billion Lives**	
Implementation Year	2010	
Location	Block: Thakurmunda District: Mayurbhanj State: Odisha	
	Beneficiary	**Non-beneficiary**
Community Name(s)	Jambani (village)	Nekedabasa (hamlet)
Number of households in community	250	50

Number of (registered) enterprises in community*	Registered – Nil Unregistered – 3 (1 LaBL VLE, 2 shops)	Nil
Average household income per month before programme instituted[53]*	1300 Rs.	900 Rs.
Most recent available average household income per month*	2800 Rs.	1700 Rs.
Distance of community from nearest tarmac road	8 km	11 km
Distance of community from electricity grid	14 km	17 km
Estimated time travel from community to block headquarter	37 km 40 minutes by road (30km) PLUS 1.5 hours on foot (7km)	40 km 40 minutes by road (30km) PLUS 2 hours on foot (10km)

3.4.3. Survey Analysis: Electricity Access and Impacts

Electricity Access Levels

Table 23 shows the average electricity access tiers for the enterprises surveyed, and the average increase in electricity access tier since before the solar lighting programme was implemented. Data is disaggregated to show the differences between *Beneficiary Respondents* and *Non-Beneficiary Respondents*. Table 24 disaggregates the enterprise electricity access levels by application, showing which applications are most frequently used and that the average application tier is for each.

Table 25 gives the same data about average tier and average increase in tier for household respondents. Table 26 provides a count of the number of households which were assessed at each attribute tier for each of the six attributes of household electricity access.

[53] Household Income before was taken from the baseline survey conducted by LaBL

* As per local self-governance body (Panchayat) records

Table 23: Enterprise Overall Electricity Access Levels, LaBL

	Beneficiary Respondents	Non-Beneficiary Respondents	Total
Number surveyed	5	7	12
Average Electricity Access Tier	**1.0**	**0.0**	**0.4**
Number of enterprises for which change in electricity access tier can be calculated	4	6	10
Average Increase in Electricity Access Tier since Programme Implementation	**1.0**	**0.0**	**0.4**

Table 24: Enterprise Application Electricity Access Levels, LaBL

			Beneficiary Respondents		Non-Beneficiary Respondents	
			Number of (Potential) Users[54]	Average Application Access Tier	Number of (Potential) Users	Average Application Access Tier
Application	**tL**	**Lighting**	5	1.0	7	0.0
	tI	**ICT & Entertainment**	0	-	0	-
	tM	**Motive Power**	0	-	0	-
	tS	**Space Heating**	0	-	0	-
	tP	**Product Heating**	0	-	0	-
	tW	**Water Heating**	0	-	0	-

Table 25: Household Electricity Access Levels, LaBL

	Beneficiary Respondents	Non-Beneficiary Respondents	Total
Number surveyed	28	27	55
Average Electricity Access Tier	**0.9**	**0.0**	**0.5**
Number of households for which change in electricity access tier can be calculated	28	27	55
Average Increase in Electricity Access Tier since Programme Implementation	**0.9**	**0.0**	**0.5**

[54] Enterprises from that category (Beneficiary/Non-Beneficiary Respondents) either using electricity for this application, or reporting an unfulfilled need for energy to provide this application (which gives them Tier 0 access). An unfulfilled need means that the application is 'strictly necessary' for the productive activity, and that the business suffers from the lack of the application in terms of productivity, sales, costs and/or quality.

Table 26: Number of households assessed at each attribute tier, LaBL

(Only includes those households with some electricity access)

			Attribute tier					
			0	**1**	**2**	**3**	**4**	**5**
Attribute	**t1**	**Capacity**		28				
	t2	**Duration/Availability**	3	12	12	1		
	t3	**Reliability**				2		26
	t4	**Quality**						
	t5	**Affordability**		28				
	t6	**Legality**						28

None of the 7 Non-Beneficiary Enterprises had any form of electricity access.

The five Beneficiary Enterprises that were surveyed all achieved an overall tier of 1. Since the only application used by these enterprises was lighting, this assessment is the same as the lighting application tier.

None of the household respondents who were not beneficiaries of the programme had any form of electricity access.

The average level of electricity access provided to surveyed households under the Lighting a Billion Lives programme is assessed as being 0.89. 11% of the household beneficiaries received Tier 0 access and the other 89% Tier 1 access. All respondents reported an electricity supply capacity of between 2Wh/day and 200Wh/day[55], consistent with the typical capacity of a solar lantern, which meant that they had Tier 1 access. All respondents paid the same monthly amount for lantern rental (Rs. 40). Although the respondents are only paying a small proportion of their income to rent the lanterns (<3% on average), they are only receiving a very small quantity of electrical energy. At an equivalent price per unit, a standard consumption package of 365 kWh/year would consume a very large proportion of their household incomes.

[55] Actual capacity 10 Wh/day

Electricity Access and Productive Uses

Table 27: Enterprise Electricity Access and Impacts, LaBL

	Beneficiary Respondents	Non-Beneficiary Respondents	Total
Number surveyed	5	7	12
Impact: Creation of New Enterprises			
Number of Enterprises Surveyed Created Since Start of Programme	1	1	2
Impact: Enterprise Revenue			
Average Enterprise Monthly Revenue	3,560 ▲	2,314 ▲[56]	2,833
Correlation Enterprise Monthly Revenue : Electricity Access Tier			62% (moderate)
% Change in Enterprise Monthly Revenue	116%	68%	84%
Correlation % Change in Enterprise Monthly Revenue : Change in Electricity Access Tier			69% (moderate)
Impact: Enterprise Profit			
Average Enterprise Monthly Profit	1,600	1,157	1,342
Correlation Enterprise Monthly Profit : Electricity Access Tier			63% (moderate)
Change in Enterprise Monthly Profit	107%	50%	69%
Correlation % Change in Enterprise Monthly Profit : Change in Electricity Access Tier			83% (strong)

The number of enterprises created since the start of the programme is very small – only a single enterprise in each community – giving little evidence of any benefit from of improved electricity access.

Beneficiary Enterprises have higher revenues than non-beneficiary by around 50%, and there is a moderate correlation between revenue and access. The difference is more pronounced for <u>changes</u> in revenue, and a similar moderate positive correlation is found. All enterprises who have achieved increased revenues attribute the increase largely or partly to better electricity access, whereas only 17% of Non-Beneficiary respondents who have increased revenues see the same link.

[56] Good confidence (94.6%) that difference exists in population, but 95% confidence threshold not achieved.

There appears to be a moderate positive relationship between profit and electricity access (though of course the direction of this relationship is undetermined), and a strong positive correlation between improved access and increased profit. Beneficiary enterprises reported more than double the increase in profit that non-beneficiaries reported.

These very small enterprises had no employees and thus any impacts on poverty from enterprise electrification will have fed through benefits to owners rather than employees.

None of the enterprises surveyed were aware of any other development initiatives that had taken place in the community since the grid extension programme implementation.

Electricity Access and Poverty Impacts

Table 28 Household Electricity Access and Impacts, LaBL

	Beneficiary Respondents	Non-Beneficiary Respondents	Total
Number surveyed	30	21	51
Impact: Household Income			
Average Monthly Household Income (Rs.)	1,543	1,104	1,327
Correlation Monthly Income : Electricity Access Tier			70% (strong)
Average % Increase in Monthly HH Income	84%	16%	50%
Correlation % Increase in Monthly Income: Increase in Electricity Access Tier			80% (strong)
% of those reporting increase in income who attribute it in whole or part to improved electricity access[57]	96%	10%	25%
Impact: Education			
% of HH with Children[58] Reporting Improvement in Education Available	36%	0%	18%
Correlation Increase in Electricity Access with Reported Improvement in Education			33% (weak)
% of those reporting improvement in education who attribute it in whole or part to improved electricity access[59]	100%	Zero respondents reported an improvement	100%

[57] Electricity access for the household or for the community

[58] In this community pair, all respondent households had children.

	Beneficiary Respondents	Non-Beneficiary Respondents	Total
Impact: Health			
% of HH Reporting Improvement in Health Care	4%	0%	2%
Correlation Increase in Electricity Access with Reported Improvement in Health Care	Too few respondents reporting improvement		
% of those reporting improvement in health care who attribute it in whole or part to improved electricity access	Too few respondents reporting improvement		

Beneficiary Households under the LaBL programme tended to have significantly higher household incomes than non-beneficiaries, and there is a strong correlation between household income and electricity access tier.

Beneficiary Households also enjoyed a far higher % increase in income (84%) compared with beneficiaries (16%), and again the strength of the correlation indicates a close relationship between the increase in income and the increase in electricity access experienced by a household. Almost all (96%) of Beneficiary respondents reporting an increase in income attribute it to improved electricity access, compared to 10% for non-beneficiaries who experienced an increase in income.[60]

A moderate proportion of Beneficiary Households reported an improvement in education (36%), whereas no Non-Beneficiary Households reported an improvement. The data display only a weak correlation with electricity access tier. All of those reporting education improvements attributed them to increased electricity access for themselves or their community.

Very few respondents reported an improvement in health care.

None of the respondents were aware of any other development initiatives that took place in the communities since the programme implementation.

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[59] Electricity access for the household or for the community

[60] The programme developers advised of some other changes affecting peoples' livelihoods that took place over the period since the lantern programme implementation:

-- The Forest Rights Act (2008) made it legal for the community to collect and use forest produce which then becomes a source of income.

-- The National Rural Employment Guarantees Act (2010), which aims at providing 100 days of paid employment to people living in rural areas, was initiated.

It is possible that the increase in income can also be attributed to these other initiatives, and that increased income might have allowed certain beneficiaries to better afford solar lantern rental.

3.4.4. Community Feedback Workshop/Focus Group Report

A Focus Group Discussion with community members was conducted in the surveyed village with over 10 participants at Jambani Lower Colony on 30th July, 2014.

Findings from the survey:

The main findings from survey are as follows, which were validated by the community members during the discussion:

a) 50 households from the beneficiary community are provided with one rechargeable solar lantern each at price of INR 40 per month per household. Each lantern caters to almost 2 days illumination need of a single household providing effective illumination for 6 – 7 hours if used at a stretch.

b) The drudgery of women also has been reduced as now her chores don't have to be postponed until morning.

c) Economic opportunities from fishing coupled with the availability of lanterns have checked migration to certain extent. For instance, four youths from the beneficiary community that earlier migrated to Andhra and Karnataka to work at brick kilns and in other industries are now self-sufficient in their own village by doing fish net mending business under the light of the lantern.

d) As cited by the villagers, education of high school students has been positively influenced by the availability of lanterns.

e) Access to illumination has led to better sanitation and hygiene as the villagers can use the lanterns while going to the lavatory or in the forest to relieve themselves

f) The main issues faced by the villagers in terms of lighting provided by lanterns are:

   - Provision of just one light per enterprise has limited the scope of SMEs and other entrepreneurial ventures to expand.
   - The tribal community is a close knit unit and so selecting a few households to benefit from the programme whilst excluding others from access to illumination has created certain amount of dismay amongst non-beneficiary households in the same community.

Energy requirements of the community

The tribes in the region have still maintained the pristine form of nature dependency. On the energy front they are satisfied with solar-based LaBL lanterns, saying it takes care of their illumination needs. The community, however, has expressed their need of energy for agriculture, health and recreation.

Problems faced by the current mode of electricity

The beneficiary community is of the opinion that the size of charging station should be enhanced to support more than one lantern per household to facilitate more income generation activities at household level such as fish net mending, leaf plate stitching etc.

Figure 10: Participants representing households and enterprises during the discussion, LaBL

Suggestions for better service:

Some of the suggestions given by the participants are as follows:

a) Peripheral un-electrified villages to be covered under LaBL to provide illumination for better living and reducing disparities.
b) Provision of more than one lantern for enterprise purposes at a higher tariff to be made.
c) Villagers see renewable energy-based Solar Multi Utility Model of Electrification more appropriate than conventional grid and therefore demand for a decentralised grid so that they can take up productive loads.
d) Bigger lanterns with higher illumination and battery backup for SME's and entrepreneurial usage.

3.5. Mlinda Foundation, Patharpratima, West Bengal [P4]

3.5.1. Description

Background

Mlinda Foundation is a Paris based organisation working on the cause of reversing environmental degradation. In India, their headquarters is at Kolkata in the state of West Bengal which is working to promote cleaner means of transport and electrification projects to reduce GHG emissions. Towards this overall objective of reversing environmental degradation, Mlinda launched a renewable energy based solar electrification project in the rural region of West Bengal where the central grid supply is not feasible. Following are the objectives stated by Mlinda on its website –

- Provide 4.2 megawatts of solar energy to 147,000 households (736,000 people) by installing 17,300 community-owned solar 225W mini-grids. Each mini-grid will be shared by 7 to 10 households
- Electrify 20,000 shops and small businesses
- Electrify 50 government school hostels and 20 private science and computer labs, along with offices and staff rooms in the four central blocks of Sundarbans and Purulia
- Create grids for local businesses that connect markets and households and provide for growing energy demands

Energy delivery model, including means and level of electricity access

The energy access programme under Mlinda is in operation through Solar Mini Grids which extensively covers the households, schools, markets and productive power segments. The project thrives on a community-based model of solar mini-grid wherein Mlinda has partnered with the National Bank for Agriculture and Rural Development (NABARD) to provide people access to low-interest loans in order to avail the benefits of a shared solar mini-grid. In partner with, NABARD, Mlinda has made possible for people to avail loans to buy the solar installations instead of relying on pay-as-you-go schemes. Solar installations are fully owned once the loan is paid off within 5 years. Loans are available to a group formed from the households known as Joint Liability Groups (JLGs). The end user repays through easy and affordable instalments over a period of five years from the direct savings accrued from non-usage of kerosene for lighting. The grids are owned by the community after repaying the banks.

These JLGs are linked to NABARD and the repayment is done by the group through monthly instalments. The entire group is held accountable in case of any bad debts which reduces the chances of delayed payments (TERI, 2014). Following are the two major models of Mlinda providing access to electricity through solar in the region of West Bengal:

Household segment model is a solar AC mini-grid system of 225 W/ 150 W consists of solar modules that are mounted on one of the houses that also keep the inverter and battery bank installed. This mini-grid is shared by 6-10 households and each system provides a household with a facility of three light points of 2W LED bulbs and a point for mobile charging. On an average, the number of hours of lighting provided by this system is 5 hours.

Market segment model is a solar AC mini-grid system which ranges between 500 Wp- 3 kWp systems. The system consists of a solar module mounted on one of the shops or the diesel generator room with housing for the inverter and battery bank. The service cables are used to connect the rest of the shops. Each shop on an average receives 5 hours of lighting per day and is provided with one/two light points for 5W or 10 W LED bulbs with a point for mobile charging point along with internal wiring and switches. The market system is debt financed by the bank and is operated and maintained by a local market entrepreneur (generally the former diesel genset operator) who repays off loan in affordable instalments within a period of 5 years.

Many attributes of the Mlinda programme such as capacity to cover needs, availability, reliability, quality and others falls under the tier 4 and 5 of the Multi-tier framework of the World Bank, but on the whole programme is rated as Tier-1 as the electricity capacity provided by the system is within 50W.

Programme cost and scale

Mlinda began the solar micro grids initiative on August 2012 with electrification of three public secondary schools in the off-grid island of Brojoballavpur in Sundarbans. This was supported by NABARD through a debt cum grant mix. This was followed with a 10 kW pilot for electrifying over 400 households in off-grid Brojoballavpur island in the Sundarbans and in the tribal Ayodha hills in the Purulia district of West Bengal. This pilot was debt financed by NABARD and United Bank of India (UBI). Mlinda has also commissioned an 8 kW system in Netaji Bazar of Brojoballavpur for powering shops as well as addressing the aspirational requirements of the households within a specified catchment area. Going forward, Mlinda has ambitious plans to install 400 kW of solar power using 1,200 micro-grids to provide electricity to 11,000 homes, 20 schools and 30 markets consisting of 1,500 small shops by the year 2015[61]. According to the recent figures provided on the organisation’s website, a total of 125 solar micro-grids are under operation in 20 villages of two districts of West Bengal (Purulia and South 24 Paraganas) reaching out to 462 houses, 150 shops and 6 schools. The total installed capacity is 52 kW. Out of these 125 solar micro-grids, around 50 are being implemented under South Asia Off-grid Access System (OASYS) project, funded by Department for International Development (DFID) and Engineering and Physical Sciences Research Council (EPSRC).

[61] http://www.mlinda.org/projects/democratising-energy-supply/

As far as programme costs is concerned, the cost for each 225W system serving 7 – 10 Households is INR 380 per Watt and for the market model of 800 Wp is INR 400 per Watt. The total capital cost for a 50kW plant is INR 17 million (Mlinda, 2014).

Impacts

Mlinda's work is driven by a clear focus on reducing greenhouse gas (GHG) emissions and therefore their work addresses two main contributors of climate change that is combustion of fossil fuels and the continuous deforestation. For dealing with these two pressing issues they are involved in three projects out of which installing an affordable, community-owned solar energy system in rural areas of West Bengal is one. Being a recent programme, there is no formal impact study which has been undertaken, however, the internal studies carried out by Mlinda and TERI do mention out few impacts arising out of Mlinda's solar micro-grid programme such as increase hours of study by children, enhanced savings through reduced expenditure on kerosene bought earlier for lighting and increased working hours resulting in additional income.

Factors facilitating/ constraining productive use of electricity access

The Mlinda model of Solar Mini-grids deals with the markets and household separately. Their solar electrification deals with two aspects, one with access to lighting provided in the households and the other is to provide access of lighting for productive use in shops. Mlinda believes that access to finance is the key factor in facilitating and constraining productive use of electricity access but other than that what is most important is, inclusivity of a model. The model has to be inclusive in the sense that could use the skill of the locals in a most efficient manner. Sometimes building capacity among the locals by working with the community is required for facilitating the take up of electricity for productive use. Another such factor important in this regard is to mentor local entrepreneur as the solar plant installation company will always be an outsider for them so building the entrepreneur's capacity is essential.

Mlinda is of the view that in order to include productive loads in electricity access one has to start from providing the basic lighting first and then catering to the inspirational needs based on the paying capacity of the people.

Key lessons from the programme

The energy access programme by Mlinda is very new and hence there is limited information on which to base key lessons of the programme. However, the Joint Liability Groups (JLGs) formed under this programme is an efficient means of availing financing schemes by the banks. Access to finance by rural people has become much easier through this concept of JLG and has augmented the financial sustainability of the project. Therefore, it is believed that the project can be easily replicated to cover a wider range of households, markets and schools and also rural institutions such as health clinics and community centres in local areas which are off-grid or with poor quality power supply in near future.

3.5.2. Community Selection

The site selected under this programme was previously un-electrified before the initiation of the programme. Mlinda Foundation has installed mini-grids in the village of Gobindopur Abad during the year 2012. This site has a sufficiently larger number of sample size with market having SMEs of both beneficiary and non-beneficiary category. Therefore, some worth noticing impacts were expected out of this site from the electrification programme. A completely off-grid non-beneficiary community, Kshetramohanpur village, was also available in the vicinity of the Beneficiary community within the same administrative block.

Table 29: Community data, Mlinda Foundation

Programme Name (P4)	**Mlinda Foundation**	
Implementation Year	2012	
Location	Block – Patharpratima District - Sundarbans, South 24 Paraganas State: West Bengal	
	Beneficiary	**Non-beneficiary**
Community Name(s)	Gobindo pur Abad (village)	Kshetramohanpur (hamlet)
Number of households in community	1221	1422
Number of (registered) enterprises in community*	20 - 22	35
Average household income per month before programme instituted*	Bottom of Pyramid (BOP) - less than Rs. 2,000 per month Middle income segment - Rs. 2,000 – 5,000 per month Upper income segment - Rs. 5,000 to Rs. 10,000 per month	Around Rs. 2,000 – 5,000 per month
Most recent available average household income per month*	No data available	No data available
Distance of community from nearest tarmac road	10 km	4 km
Distance of community from electricity grid	16 km	8 km
Estimated time travel from community to block headquarter	Approx.1.5 hours	Approx.1 hour

* As per local self-governance body (Panchayat) records

3.5.3. Survey Analysis: Electricity Access and Impacts

Electricity Access Levels

Table 30 shows the average electricity access tiers for the enterprises surveyed, and the average increase in electricity access tier since before the mini-grid programme was implemented. Data is disaggregated to show the differences between *Beneficiary Respondents* and *Non-Beneficiary Respondents*. Table 31 disaggregates the enterprise electricity access levels by application, showing which applications are most frequently used and that the average application tier is for each.

Table 32 gives the same data about average tier and average increase in tier for household respondents. Table 33 provides a count of the number of households which were assessed at each attribute tier for each of the six attributes of household electricity access.

Table 30: Enterprise Overall Electricity Access Levels, Mlinda

	Beneficiary Respondents	Non-Beneficiary Respondents	Total
Number surveyed	5	6	11
Average Electricity Access Tier	**1.0**	**0.0**	**0.5**
Number of enterprises for which change in electricity access tier can be calculated	5	0	5
Average Increase in Electricity Access Tier since Programme Implementation	**0.2**	**-**	**0.2**

Table 31: Enterprise Application Electricity Access Levels, Mlinda

			Beneficiary Respondents		Non-Beneficiary Respondents	
			Number of (Potential) Users[62]	Average Application Access Tier	Number of (Potential) Users	Average Application Access Tier
Atpplication	tL	Lighting	5	1.00	6	0.00
	tI	ICT & Entertainment	0	-	0	-
	tM	Motive Power	0	-	0	-
	tS	Space Heating	0	-	0	-
	tP	Product Heating	0	-	0	-
	tW	Water Heating	0	-	0	-

Table 32: Household Electricity Access Levels, Mlinda

	Beneficiary Respondents	Non-Beneficiary Respondents	Total
Number surveyed	27	24	51
Average Electricity Access Tier	**1.0**	**0.1**	**0.6**
Number of households for which change in electricity access tier can be calculated	27	24	51
Average Increase in Electricity Access Tier since Programme Implementation	**0.8**	**0.1**	**0.5**

Table 33: Number of households assessed at each attribute tier, Mlinda

(Only includes those households with some electricity access)

			Attribute tier					
			0	1	2	3	4	5
Attribute	t1	Capacity		29				
	t2	Duration/Availability			29			
	t3	Reliability						29
	t4	Quality						29
	t5	Affordability		26				3
	t6	Legality			26			3

[62] Enterprises from that category (Beneficiary/Non-Beneficiary Respondents) either using electricity for this application, or reporting an unfulfilled need for energy to provide this application (which gives them Tier 0 access). An unfulfilled need means that the application is 'strictly necessary' for the productive activity, and that the business suffers from the lack of the application in terms of productivity, sales, costs and/or quality.

None of the six Non-Beneficiary Enterprises had any form of electricity access.

The five Beneficiary Enterprises that were surveyed all achieved an overall tier of 1. Since the only application used by these enterprises was lighting, this assessment is the same as the lighting application tier.

This case study is unique amongst the four presented in this report because the majority of Beneficiary Enterprises did not see an increase in electricity access tier as a result of the programme although their source of electricity changed. Four of the five Beneficiary Enterprises used to receive electricity supply from a neighbouring entrepreneur who owned a diesel generator. This arrangement was an informal mini-grid, which gave the connected enterprises surveyed Tier 1 access.

Most of the household respondents who were not beneficiaries of the programme had no form of electricity access. The exceptions were three respondents who used Solar Home Systems, which offered them Tier 1 access both before programme implementation and at the time of survey.

All household beneficiaries of the Mlinda programme surveyed are assessed as having Tier 1 access. The attributes that contributed most often to a low tier assessment were capacity and affordability, with all interviewees reporting an electricity supply capacity of between 1W and 50W and the cost of a 1 kWh/day energy consumption typically well beyond 10% of household income.

Prior to the implementation of the programme, six of the 27 Beneficiary households had Solar Home Systems which mostly gave them Tier 1 access, whereas the other respondents had no form of electricity access.

Electricity Access and Productive Uses

Table 34: Enterprise Electricity Access and Impacts, Mlinda

	Beneficiary Respondents	Non-Beneficiary Respondents	Total
Number surveyed	5	6	11
Impact: Creation of New Enterprises			
Number of Enterprises Surveyed Created Since Start of Programme	0	0	0
Impact: Enterprise Revenue			
Average Enterprise Monthly Revenue	7,600 ▲	4,667 ▲ [63]	6,000
Correlation Enterprise Monthly Revenue : Electricity Access Tier			52% (moderate)
% Change in Enterprise Monthly Revenue	20% ▲ [64]	0% ▲	11%
Impact: Enterprise Profit			
Average Enterprise Monthly Profit	2,900 ▲	1,117 ▲ [65]	1,927
Correlation Enterprise Monthly Profit : Electricity Access Tier			62% (moderate)
% Change in Enterprise Monthly Profit	13% ▲	0% ▲ [66]	7%

None of the surveyed enterprises were created since the start of the programme.

Both the average revenues and profits for Beneficiary Enterprises are substantially higher than for Non-Beneficiary Enterprises. There are moderate correlations between revenue and access tier, and between profit and access tier.

Beneficiary Enterprises appear to have seen a greater increase in both revenues and profits since programme implementation, but upon inspection only one respondent reported a change in each case and so no meaningful correlations can be drawn between increased revenues/profits and increased electricity access.

[63] Good confidence (88%) that difference exists in population, but 95% confidence threshold not achieved.

[64] Only one respondent reported a change

[65] Good confidence (94%) that difference exists in population, but 95% confidence threshold not achieved.

[66] Low confidence (65%) that difference indicated in the sample exists in the wider population.

None of the enterprises surveyed were aware of any other development initiatives that had taken place in the community since the grid extension programme implementation.

Electricity Access and Poverty Impacts

Table 35: Household Electricity Access and Impacts, Mlinda

	Beneficiary Respondents	Non-Beneficiary Respondents	Total
Number surveyed	27	24	51
Impact: Household Income			
Average Monthly Household Income (Rs.)	6,926 ▲	2,563 ▲[67]	4,873
Correlation Monthly Income : Electricity Access Tier			23% (weak)
Average % Increase in Monthly HH Income	2%	0%	1%
Impact: Education			
% of HH with Children[68] Reporting Improvement in Education Available	67%	0%	35%
Correlation Increase in Electricity Access with Reported Improvement in Education			59% (moderate)
% of those reporting improvement in education who attribute it in whole or part to improved electricity access[69]	78%	0%	78%
Impact: Health			
% of HH Reporting Improvement in Health Care	4%	0%	2%
Correlation Increase in Electricity Access with Reported Improvement in Health Care	Too few respondents reporting improvement		
% of those reporting improvement in health care who attribute it in whole or part to improved electricity access	Too few respondents reporting improvement		

For this community pair, Beneficiary Households under the Mlinda programme have substantially greater household incomes than non-beneficiaries – almost three times

[67] Good confidence (93%) that difference exists in population, but 95% confidence threshold not achieved.

[68] In this community pair, all respondent households had children.

[69] Electricity access for the household <u>or</u> for the community

higher. However, the relationship between income and electricity access level is not clear-cut, with only a weak correlation present.

No respondents reported a significant change in household income since the programme implementation. This is not necessarily surprising, since the programme was implemented in 2012, only two years before the surveys took place.

Two-thirds of Beneficiary Households reported an improvement in education, whereas nil Non-Beneficiary Households felt that education for their children had improved. There is a moderate correlation between this factor and a change in electricity access, but 78% of beneficiaries reporting an improvement in education attributed this to increased electricity access for themselves or their community.

Very few respondents reported an improvement in healthcare.

None of the respondents were aware of any other development initiatives that took place in the communities since the programme implementation.

3.5.4. Community Feedback Workshop/Focus Group Report

The focus group discussion was held with around 10 participants on 16th August 2014 with the community members from Gobindapur Abad village of Brojoballavpur Gram Panchayat.

Findings from the survey

The following findings were validated by the community members during the discussion:

a) Each household is provided with three light points and a mobile charging point which accounts for 11W of total electricity supply per household.
b) Electricity is provided for 5 hours, between 6pm to 11pm.
c) The system is operating by the end user by forming a Joint Liability Group. The monthly charges for the lighting are depending on the number of the members of the JLGs.
d) For the household the supply is only for lighting and mobile charging. However, people require more capacity for running fan and TV in their households which is not possible from the current supply of the system. Also, the supply is only for 5 hours during evening even though people feel the requirement of using light during the day time.

Figure 11: Village members expressing their views during the focus group discussion, Mlinda Foundation

Energy requirements of the community

Other than having more wattage supply to run a fan and a TV, few villagers also wished to have supply catering to their needs for irrigation and water pumping. They also felt the requirement of better electricity in schools so that their children could take advantage and may be an opportunity to learn computers. Also, the villagers demand more supply so that they can use small appliances in the market such as the ones required by a health care practitioner in the village or a barber.

Problems faced by the current mode of electricity

One issue that emerged out from this discussion is that villagers feel that formation of a JLG (Joint Liability Group) sometimes become difficult due to non-agreement of the people to join or facing difficulty in making any decision.

Suggestions for better service

The participants of the discussion gave a few suggestions for better provision of service which are as follows:

a) A facility for providing electricity as per the demand of individuals should be made, such that it may be used for fan and TV in the house hold and productive loads in the market as well.

b) The duration of hours for which the electricity was provided should increase, and it must be provided during the day time for those who require it for running their enterprise (e.g., barber shop and doctor).

Figure 12: Focus group discussion, Mlinda Foundation

4. Factors Affecting Provision, Take Up and Use of Electricity for Productive Purposes

This Case Study has investigated the factors that affect the take up and productive use of electricity access in India through the Policy/Regulatory Framework Review, Stakeholder Consultations and field research. The principal factors identified through these three exercises are discussed in turn, and evidence presented regarding the relative importance of the factors.

4.1. Policy and Regulation

Energy policy and regulation can directly assist or hinder provision of electricity access and affect how straightforward it is for potential users to take up access (particularly connection to the main grid). In addition the wider legal and regulatory framework may affect users' ability to make productive use of electricity. Table 36 lists the key enabling and constraining factors identified through the Policy and Regulatory Review and Stakeholder Consultations.

Table 36: Enabling and Constraining Factors: Policy and Regulation

	Enabling Factors	Constraining Factors
Provision of access	Ambitious rural electrification targets, dedicated budget, institutional responsibilities and electricity access programmes are in place	Multiplicity of electrification programmes has constrained impact
	Capital subsidy available for rural electrification projects	Subsidy support assists only with upfront costs - not ongoing costs which are equally challenging for developers
	Active cross-subsidisation of rural electricity consumption keeps grid tariffs low in rural areas	Overemphasis by the utilities on serving urban and industrial customers
	Off-grid electricity suppliers may charge tariffs that differ from the main grid tariff	Off-grid electricity supplies receive no support through cross-subsidisation which harms their viability
	Developers of off-grid electricity supplies in notified rural areas do not require licences or permits	Lack of clarity regarding grid extension plans, or provision for off-grid systems in the event of grid overlap, leave developers vulnerable

	Enabling Factors	Constraining Factors
Take up and productive use	A subsidy of around 40% is available for purchasers of SHS, with loans provided for the remainder by Rural Development Banks.	Banks require the beneficiary to offer collateral for securing the SHS loan, which many rural households are unable to provide
		Off-grid electricity supplies receive no support through cross-subsidisation which harms the ability of off-grid consumers to make productive use of electricity
		Productive uses of electricity are not given enough importance at the design stage of policies and programmes.

4.2. Quality/performance of electricity supply

The assessment of the performance of electricity supplies formed a major part of the field research analysis presented in Section 3. Using the SE4ALL Global Tracking Framework, the electricity supply received by each interviewee was assessed in terms of capacity, duration/availability, reliability, quality, affordability and legality. Enterprise respondents were also assessed in terms of the health and safety features and convenience of their electricity supply. These assessments have allowed a quasi-quantitative assessment of the attributes that constitute electricity access, and suggest the attributes that most severely constrain the level of electricity access achieved by each household or enterprise.

In the communities studied, the assessed level of access for households appears to be driven almost entirely by capacity and affordability, with many respondents being assessed at either Tier 0 or Tier 1 for more than one of these attributes as shown in Table 32. Duration/availability also plays a part in limiting the tier which households achieve.

Table 32: Number of households assessed at each attribute tier

			Attribute tier					
			0	**1**	**2**	**3**	**4**	**5**
Attribute	**t1**	**Capacity**	1	103	21			
	t2	**Duration/Availability**	10	23	68	24		
	t3	**Reliability**				55		67
	t4	**Quality**			29			67
	t5	**Affordability**		100				24
	t6	**Legality**			29			96

For enterprises, capacity and availability are the dominant drivers of the level of access, with quality playing a much more minor role. Affordability appears to be less of a constraint for Indian enterprises. This aligns with expectations that energy costs typically represent only a small proportion of a small rural enterprise's expenditure.

These assessments indicate that the greatest constraints arising from the characteristics of the supply on the take-up and use of available electricity access are low capacity, poor availability and (for households) high cost.

However, the barriers as indicated by the tier assessment and the barriers/enablers as perceived by users themselves may differ. For example, comments from community members at all four focus groups highlighted quality, reliability and duration/availability as important constraints to their household and productive use of electricity access. Capacity was also highlighted in the focus groups for the two mini-grid programmes (Husk Power Systems and Mlinda Foundation) and the Lighting a Billion Lives solar lantern programme.

Stakeholders in electricity access provision were more concerned with unreliability, whether of on- or off-grid supplies, and poor power quality as constraining factors for the productive uptake of electricity access. The agricultural feeder separation programme was cited as a good example of an intervention that can improve the availability, reliability and quality of electricity supply for households and enterprises. Feeder separation also has the potential to reduce costs for the grid system overall by limiting power wastage at the point of use as well as reducing transmission and distribution losses.

4.3. Costs and Access to Finance

In India, grid electricity is subsidised, and charging tariffs below the cost of generation is not uncommon. Furthermore, heavily subsidised tariffs are available for BPL consumers (covering a 'lifeline' quantity of electricity per month), as well as subsidies for the upfront cost of connection. This means that for the rural poor, the low cost of grid electricity can be an enabler of take up and productive use of small quantities of power. However, as found when the level of access of households in the case study communities was assessed, the cost of a medium amount of electricity (162 kWh/month as suggested by the draft Global Tracking Framework applied in this study) would be beyond the range of affordability for the very poor, subsidy or no subsidy.

For off-grid electricity supplies, connection and consumption costs are normally higher and typically are not subsidised, meaning that costs can be a barrier to the take up and productive use of electricity access by households and enterprises in more remote communities. An exception is found in the case of solar home systems, which are subsidised to the value of 40% with favourable loans available to the end user to cover the balance. In the communities studied, the upfront cost of electricity was the most frequently stated barrier to the take up of household electricity access.

Likewise, high operating costs present severe challenges for developers of projects implemented in remote areas. The capital subsidies offered by the Indian government for off-grid installations are an important enabler. However, the difficulties that developers face regarding recovery of ongoing costs are barriers to potential investors.

Most respondents believe that while the costs are high at present, they are rapidly declining owing to improvements in technological efficiency. If supported through correctly designed incentive schemes, it is likely that even off-grid technologies will become affordable for productive applications in rural areas.

4.4. Skills and Access to Markets

Interviewed stakeholders felt that skills requirements are among the most severe barriers to the successful uptake of new productive activities following an increase in electricity access. Skills are one reason why it was felt that economic benefits of electricity access were better in those communities in which there was a pre-existing productive activity that could be profitably adapted to use electricity. However, the focus groups did not find that the beneficiaries of electricity access programmes saw the lack of knowledge, skills or capabilities as such a severe barrier.

A similar level of importance was placed by stakeholders on access to markets as an enabler (if present) or constraint (if absent) to the productive use of electricity.

4.5. Relative Importance of Factors

The factors that household respondents felt were influential with respect to their decision whether to take up improved electricity access were investigated via a series of survey questions.

Figure 13 shows the percentage of respondents who feel that a particular factor has, or would, positively influence their decision whether to take up improved electricity access. This influence may be positive (encouraging the take up of electricity access) or negative (discouraging take up), and can be derived from the presence or absence of factors that may be perceived as “good” or “bad”. The data is weighted such that the opinions of the Beneficiary and Non-Beneficiary household groups have equal impact.

The percentages stating each factor as an influence are high, reflecting the numerous facets of electricity access and the enabling environment that people consider important, and the complexity of the decision.

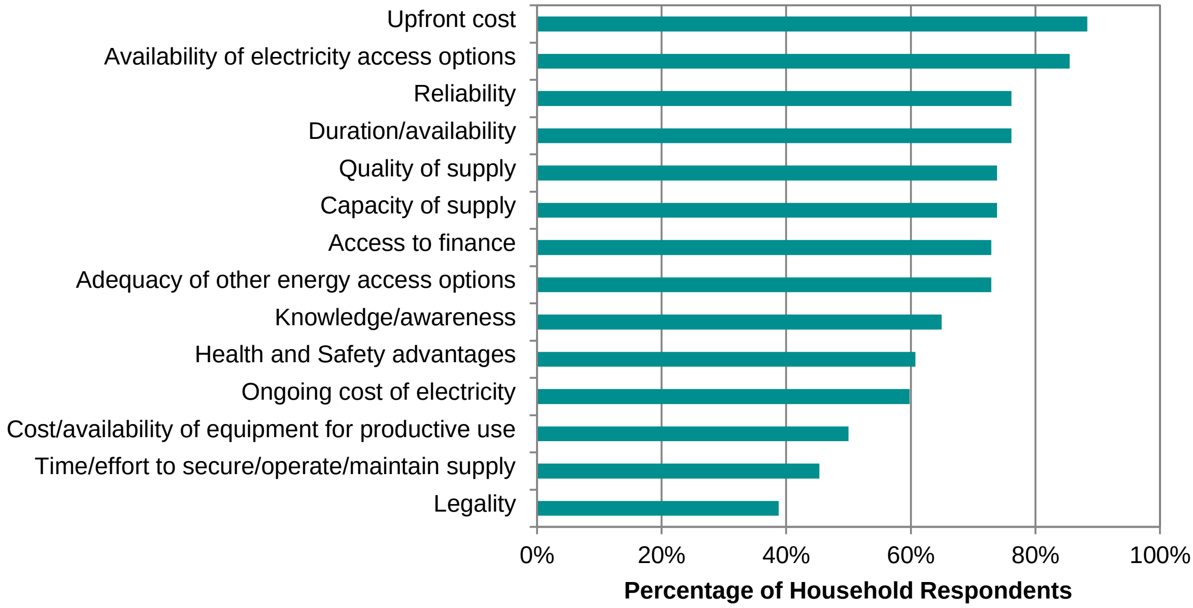


Figure 13: Household Influencing Factors (Taking Up Electricity Access)

Enterprise and productive use respondents were asked about the factors that influence them to make productive use of electricity access.

Figure 14 shows the percentage of respondents who feel that a particular factor has, or would, positively influence their decision whether to make productive use of electricity access. Again, the percentages stating each factor as an influence are high.

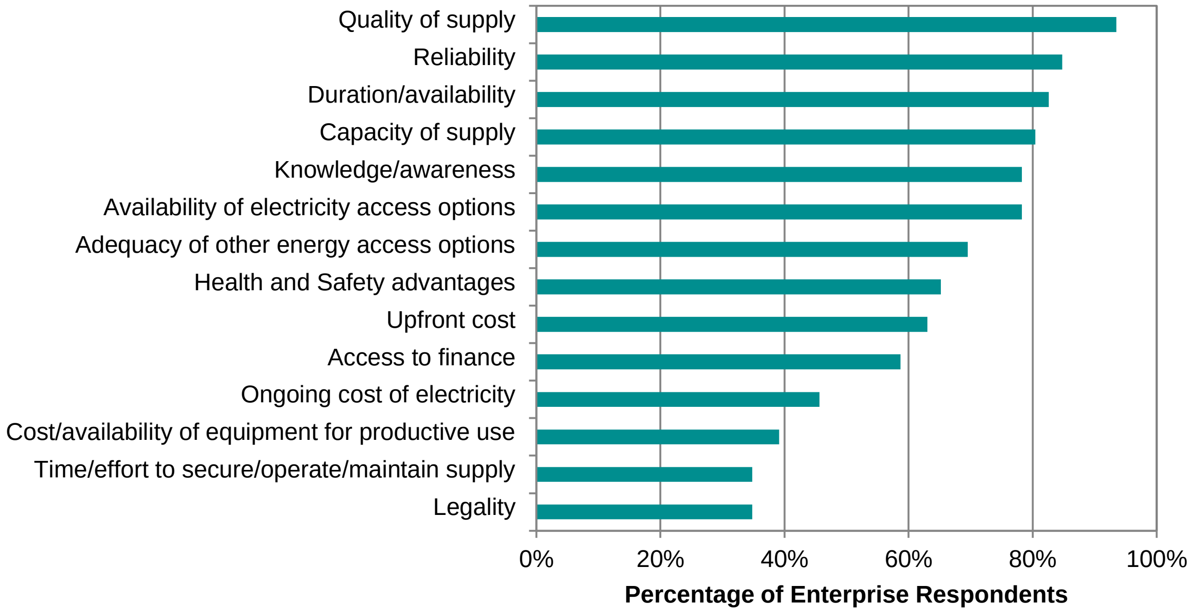


Figure 14: Productive Use Influencing Factors

In both figures, quality, reliability and duration/availability of supply are most frequently reported as influencing factors (#3, #4 and #5 among households, #1, #2 and #3 among enterprises). This agrees well with the reports from the community workshops/ focus groups, who all reported these three factors as being important constraints to their household and productive use of electricity access.

Capacity was also highlighted in the focus groups for the two mini-grid programmes (Husk Power Systems and Mlinda Foundation) and the Lighting a Billion Lives solar lantern programme. Unsurprisingly, capacity also finds itself high on the list of influencing factors from the survey (#6 for households, #4 for enterprises).

5. Value for Money

By comparing average through-life costs[70] in terms of $/user/year for each of the programmes[71] (based on data provided by the programme developers, supplemented, where necessary by generic data) with the average level of access[72] they achieve, it is possible to arrive at some broad observations regarding the relative value for money provided by the various means of electricity provision.

Data provided by the programme developers supplemented with generic data was used to calculate the costs of providing electricity access under each of the programmes studied. The capital costs of the equipment (generating plant, distribution system, solar equipment etc.) and the costs of implementing the programme were brought together with operating and maintenance costs, fuel costs and administration costs, using a 15% discount rate, to derive an average annual cost of electricity provision per user for each programme. (These are costs of providing electricity and not the prices charged to users. They do not include costs, such as wiring or appliance costs[73], which will be incurred by end-users if electricity supply is to be transformed into electricity services.)

It should be noted that the costs derived may not be directly comparable or necessarily representative of the costs of the various forms of electricity provision in a wider context because:

- They include programme development and ongoing overhead/administration costs, and the impact these have on cost per kW (or per year) will be very much affected by the scale at which the programme has been implemented
- Mini-grid and grid extension costs in particular (and, to a lesser extent, costs of other forms of electricity) are highly location specific, being affected by geography (distance from the existing grid system), local topography, availability of primary energy resources for generation, size and population density of the community served, as can be seen by the very different costs reported by the Husk Power and Mlinda Foundation mini-grid programmes (see below). Thus it is highly unlikely that the costs mini-grid(s) installed in

[70] Costs are in 2014 terms.

[71] Community-specific costs for the RGGVY grid extension programme were not available and average "cost-of-service" figures for the grid system in West Bengal (see Tariff Order 2011-12 and 2012-13, West Bengal Electricity Regulatory Commission, 1st December 2012), which encompass both urban and rural areas, were not judged to provide a useful comparator with the rural community electricity access programmes which form the focus of this study.

[72] Arrived at by simple averaging of the average household and average productive use access level reported by programme beneficiaries

[73] With the exception of solar lanterns where the end-use appliance is not divisible from the means of provision.

communities served by the LABL programme would reflect those of the HPS or Mlinda Foundation mini-grids

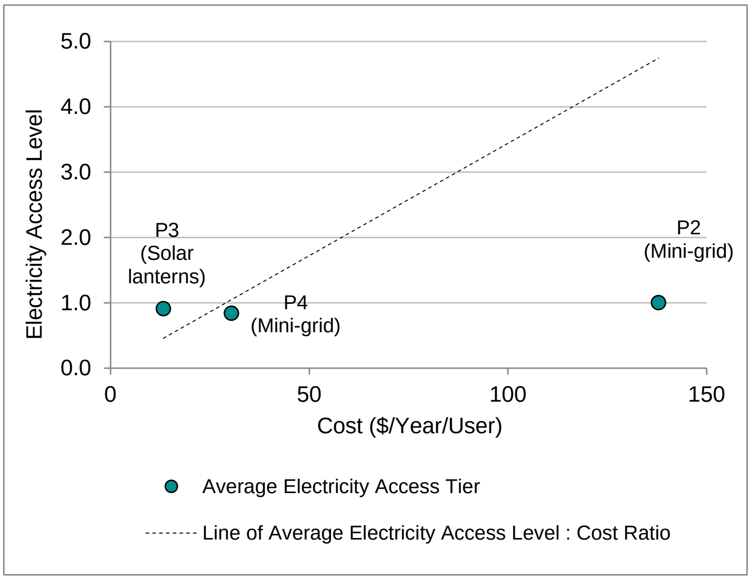
- The electricity access levels also represent a combination of household and productive use tiers – which are not strictly comparable, as the productive use tier may represent one or more electricity applications.

Despite these limitations, by looking at how the resulting electricity access levels and impact on beneficiaries' household income compared with the cost of provision, some inferences could be drawn regarding the relative value for money provided by the alternative means of provision.

In relation to the costs it is notable that those achieved by the HPS programme are substantially lower than those for the Mlinda Foundation programme. This cost differential is primarily driven by the Mlinda Foundation programme's higher capital costs, reflecting both the different technology employed and the very substantial difference in the scale of the mini-grids deployed, even though the average user demand is closely comparable between the two programmes. Though the HPS biomass generators also incur some fuel costs, these are not significant compared with the capital cost differential.

The LABL programme represents a very different model and though its capital costs are substantially lower than the Husk Power and Mlinda Foundation programmes, the volume of energy provided is also substantially lower (despite the access tier level being similar), and hence the cost per kWh is significantly higher, though the cost per user per year remains lower than for the two mini-grid programmes.

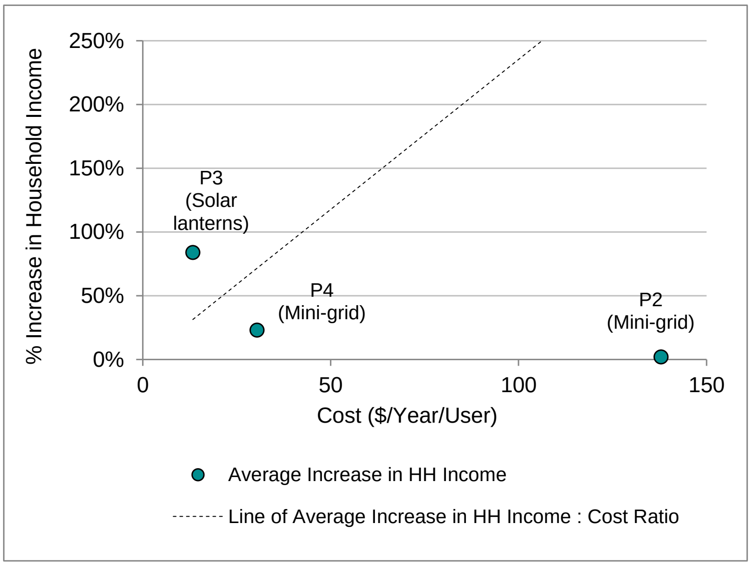
Figure 15: Average Electricity Access Level vs Cost (excluding Grid Extension Programme)



As discussed in Section 3, all three of these programmes, despite the different forms of electricity provision, achieve very similar levels of access, and on this basis it is those with the lowest cost (the LABL solar lantern programme, and then the Husk Power mini-grid programme), which appear to provide the stronger value for money.

On the basis that electricity access is not an end in itself, but a means to enable poverty reduction, the costs of the various programmes have also been plotted against the average percentage increase in beneficiary household incomes:

Figure 16: Average Increase in Household Income vs Cost (excluding Grid Extension Programme)



Since it is the LABL solar lantern programme which has supported the greatest increase in household income, at the lowest cost it is unsurprising that it has delivered well above average value for money. By contrast the Husk Power mini-grid, having supported a significantly lower increase in household income at higher cost, lies just below the average benefit : cost line while the Mlinda mini-grid, for which no increase in household income is reported and for which costs are higher appears to have provided least value for money in these terms.

However, as discussed above, each of these programmes has operated in a specific context which has largely driven the household income benefits achieved through electricity access provision, and in comparing them it must be recalled that both the literature and the evidence from these programmes indicate that the poverty impact of electricity access is dependent not only on the level of access but also on the social and economic context in which it is provided and the availability of a number of other factors. Thus great caution should be taken in drawing any general conclusions about the relative value of different forms of electricity provision from these specific cases – what provides the greatest value for money in one context may give very different results in another context.

6. Conclusions and Recommendations

6.1. Electricity Access Context

A detailed scrutiny of all the legislations, policies and programmes in the Indian electricity access space reveals that access to electricity services for productive use has either been least prioritised or has received indirect attention. It is through the linking of energy access provision with livelihood creation and income generation that the goals of socio-economic development will be achieved. Further, there is also a need to consolidate some of India's numerous energy access programmes and make them more focused to derive full benefit from the government's considerable investment in electricity provision.

The Indian government provides substantial financial support for rural electrification through capital subsidies for off-grid access programmes and for household-level solar generation equipment. However, the developers of off-grid installations still face formidable challenges in achieving cost recovery without charging very high tariffs for the electricity supplied (which would put electricity access beyond the reach of the poorest anyway). End users themselves can struggle to afford the upfront costs of electricity access when they are unable to secure loans due to a lack of assets for collateral.

The grid electricity system provides cross-subsidy for rural electricity connections. The artificially low tariffs in rural areas enable the take up of electricity access by households that otherwise could not afford to do so. However, equivalent support is not extended to off-grid electricity provision, meaning that consumers are less able to afford off-grid power and/or the investment case for developers is weaker. Crucially, high power prices in off-grid areas make enterprises situated there less competitive than their rivals who can make use of grid electricity.

Other policy-related factors influence the electricity access situation in India, such as the uncertainty regarding grid extension plans, the recent de-licensing of off-grid generation and distribution in rural areas and the 'locking-in' of low levels of consumption in marginalised areas by the installation of undersized transmission and distribution equipment.

In terms of electricity access programme development, the focus on lifeline supply and household electrification has not created environments in which electricity-using enterprises can grow and prosper. This has limited the poverty impact of rural electrification in terms of people's incomes, although electricity supply to education and healthcare facilities has had clear and important welfare outcomes. This said, there are many other factors beyond the electricity supply itself that must act in favour of enterprise development in order for the hoped-for 'virtuous cycle' of poverty reduction to be set in motion; access to markets, skills, raw materials and infrastructure are all crucial enabling factors.

6.2. Impacts of Electricity Access in Case Study Communities

The field research undertaken as part of this case study has allowed the direct examination of relationships between level of electricity access, productive use and poverty impacts, using primary data derived from surveys of households and enterprises in communities included in four electricity access programmes.

Creation of Enterprises – No significant difference was observed in the rate of enterprise creation between beneficiary and non-beneficiary communities, although the sample size under consideration is very small.

Employment and Time Use – Overall, the employment rate was significantly higher amongst the non-beneficiaries interviewed compared to the beneficiary group. However, more non-beneficiaries had also been employed prior to the implementation of the energy access programmes. The change in employment was much the same for both groups, providing no evidence in favour of the assertion that electricity access enables increased employment through shifts in time use. Instead, it may be that increased economic activity (in both beneficiary and non-beneficiary communities), whether or not fuelled by electricity access in the vicinity, has promoted increased employment.

Furthermore, it appears that the increases in employment are being felt predominantly by men, with no net change in employment recorded amongst the female interviewees. However, anecdotal evidence was found in the case of the Lighting a Billion Lives lantern programme that electricity access reduced drudgery for women by enabling them to carry out chores outside of daylight hours.

The enterprises surveyed only rarely employed anyone outside of the family unit and so correlations could not be drawn between the changes in the number of people employed by each enterprise and the changes in electricity access tier experienced by those enterprises.

Enterprise Revenue and Profit – Considering all four community pairs, the surveyed beneficiary and non-beneficiary enterprises enjoyed revenues that were almost identical. The difference in overall average revenue increases was also insignificant.

Beneficiary enterprise average profits were 23% higher than those of non-beneficiaries amongst those enterprises surveyed, and it appeared that beneficiaries had seen a greater increase in profit (although only low confidence can be placed in this result).

Within each community pair, correlations between the level of electricity access and revenues or profits were moderately or strongly positive for two of the programmes (the Mlinda Foundation mini-grid and the Lighting a Billion Lives lantern programme). However, the RGGVY grid extension programme and Husk Power Systems mini-grid data showed weakly positive, negligible or moderately negative correlations. The latter finding (applying to current profit and electricity access tier, and to changes in revenue/profits and changes in electricity access tier for the Husk Power Systems community pair) is especially surprising given that these two programmes were expected to provide the best levels of electricity access and hence the clearest impacts. The inconsistency of direction of correlations implies that the impacts of electricity access are highly dependent on context.

Poverty Impacts – In all cases, the average household income of beneficiary households was higher than that of non-beneficiary households. However, patterns in the income increases were not consistent, with non-beneficiaries seeing slightly higher increases under the RGGVY grid extension and Husk Power Systems mini-grid programmes. Under the Lighting a Billion Lives lantern programme, beneficiaries saw an average 84% increase in income whereas non-beneficiaries saw only 16%. The two groups started off with similar incomes. The households in the Mlinda mini-grid community pair saw no substantial change in their income whether or not they were beneficiaries (but it must be noted that the mini-grid implementation was the most recent among the programmes studied). Negligible correlations were found between the (change in) level of electricity access and the (change in) household incomes, except in the case of the Lighting a Billion Lives programme, where strong correlations were found between current access and income and the change in access tier and change in income.

In every community pair, the beneficiary households with children were much more likely to report that there had been an improvement in the education available to them; overall, 51% of beneficiaries reported an improvement compared to only 2% of non-beneficiaries. A majority of respondents attributed an improvement in whole or in part to improved electricity access; in some communities, 100% made this connection.

In three of four community pairs, almost no respondents had perceived an improvement in the healthcare available to them since programme implementation. In the Husk Power System mini-grid community pair, 40% of beneficiaries (but no non-beneficiaries) reported an improvement, all of whom attributed this at least in part to improved electricity access.

Overall, the research has not revealed a consistent relationship between levels of electricity access and its impacts in terms of either productive activity or poverty reduction. In certain instances patterns have emerged to support the assertion that improved electricity access can lead to enhanced levels of productive activity, although the subsequent link to poverty reduction is more difficult to observe. However, examination of other impact indicators has often discerned no relationship or, occasionally, found influence in the opposite direction to that anticipated.

An exception to this disordered picture is found in the impacts of the Lighting a Billion Lives programme, where the provision of lighting-only electricity access appears to have enabled appreciable impacts. For enterprises, the move from Tier 0 to Tier 1 access has been accompanied by substantial increases in revenue and profits, with strong correlations being found between the level of electricity access and enterprise performance. For households, the correlation between monthly income and electricity access tier is also strong. Beneficiary households appear to have moved from an initial income position slightly behind that of non-beneficiaries to having incomes around 50% higher. A third of respondents with children report an improvement in the education available to them and attribute this at least partly to electricity access.

6.3. Recommendations for Policy Makers and Programme Developers

To improve the enabling environment for electricity access and its productive use in India, it is suggested that policymakers:

- Develop policies which prioritise electricity for productive use alongside basic electricity access for households;
- Rationalise the current multiplicity of initiatives and programmes to achieve more effective support for electricity access;
- Encourage those States which have not already done so to develop a rural electrification plan (in line with the Electricity Act 2003);
- Encourage co-operation between different government departments and ministries, and convergence between electricity access programmes and livelihood/enterprise development initiatives;
- Link policies and plans for electricity access with policies aimed at overcoming other barriers faced by rural communities in relation to access to markets, poor infrastructure and inadequate skills;
- Provide clarity regarding the details of future grid extension plans and develop open access databases to map locations of existing and planned energy access projects;
- Establish regulatory provision to deal with the position of any previously established mini-grids within an area into which the national grid is extended;
- Seek to equalise support and subsidy arrangements between grid and off-grid electricity access in a pro-poor manner, redirecting some of the support currently available to grid-connected consumers to counter-balance the high costs of remote, off-grid provision and the cross-subsidization effects inherent in grid systems;
- Promote the development of credit facilities with reduced collateral requirements for both electricity access providers and users

To increase the poverty impact of electricity access, it is suggested that programme developers seek to:

- Incorporate provision for productive use in programmes alongside basic electricity access for households;

- Consider the productive use opportunities available to communities and tailor electricity access provided to meet those productive needs;

- Address issues of reliability and quality of rural electricity supplies as well as capacity;

- Link electricity provision with wider development efforts to tackle the barriers to enterprise development that would otherwise constrain its productive use and hinder poverty reduction - poor infrastructure, inaccessible markets, skills shortages and lack of access to finance.

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