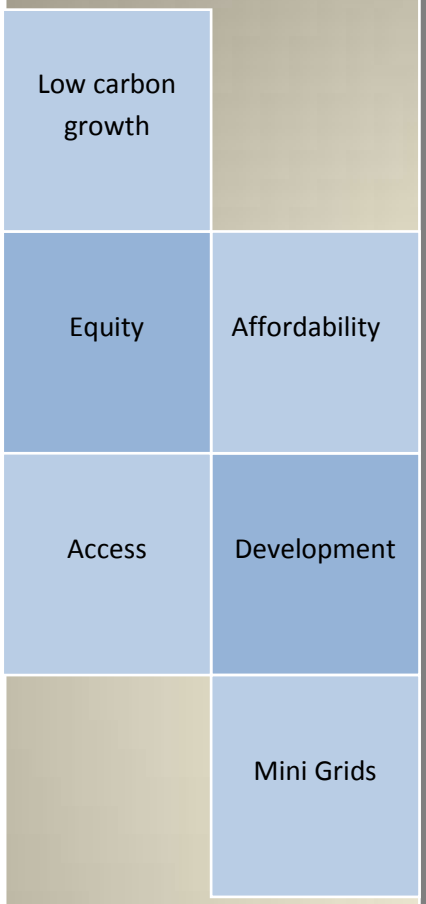

Powering Empowerment: Decentralized Renewable Energy for Rural Electrification

Policies, Experiences and the way forward

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Girish Sant Memorial Young Research Fellowship 2013

Prayas and several friends and well-wishers of Girish Sant, a pioneering policy researcher and public interest advocate in the energy sector who passed away unexpectedly in February 2012, have set up a Young Researcher Fellowship (YRF) to encourage young researchers to imbibe his values and approach of high quality analysis, commitment to social equity and emphasis on policy impacts. This report is dedicated to the memory of Girish sir whose urge for quality analysis has been a guiding light for me.

Acknowledgements

I would like to use this opportunity to thank The Girish Sant Memorial committee for giving me chance to work on such a project without which I could not have completed the report. I remember the support and guidance received from the Prayas Energy Group team. Their Valuable support has always helped me to keep in pace with the fellowship journey. I would like to thank various NGO's, Government organisations who have supported me with necessary permissions and field support. I would like to thank various communities, translators who have given immense support with their cooperation in interviews, focus group Discussions etc. I would like to extend my gratitude to my friends and family members who helped through this journey. I thank almighty god for his enormous blessings.

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List of Abbreviations

BPL	Below Poverty Line
BRICS	Brazil Russia India China South Africa
CERC	Central Electricity Regulatory Commission
CFL	Compact Fluorescent Lamp
CREDA	Chattisgarh Renewable Energy Development Agency
DDG	Decentralized Distributed Generation
DFID	Department for International Development
DISCOM's	Distribution Companies
DRE	Decentralized Renewable Energy
EDI	Energy Development Index
HRD	Human Resource Development
MDG	Millennium Development Goals
M&E	Monitoring and Evaluation
MNRE	Ministry of New and Renewable Energy
MoP	Ministry of Power
NABARD	National Bank for Agriculture and Rural Development
NCEF	National Clean Energy Fund
NGO	Non- Governmental Organisation
O&M	Operation and Maintenance
PHC	Public Health Centre
PV	Photo Voltaic
RE	Renewable Energy
REC	Rural Electrification Corporation
REC	Rural Electricity Cooperatives
REP	Rural Electrification Policy
RGGVY	Rajiv Gandhi Grameen Vidyutikaran Yojana
RPO	Renewables Purchase Obligation

SEB	State Electricity Board
SHG	Self-Help Groups
SME	Small and Medium Enterprises
TEDA	Tamil Nadu Energy Development Authority
VEC	Village Electricity Committees

Executive Summary

India is looking forward to leapfrog in renewable energy (RE) deployment in the coming decade. With 300 million people still lacking energy access this would also translate in to an effective method for tackling energy poverty coupled with a low carbon growth. Such a transition has opened up the entire ecosystem of 'renewables for rural electrification' with a multitude of actors with varied interests and under complex policy and governance systems. The report with a combination of policy and action research focuses on creating a framework for ensuring energy access using renewables while analysing the existing scenario in this space.

The ultimate aim is to create visibility for the issue in the public space followed by a framework for action that can create a win-win situation for both the beneficiaries and the developers. It is expected to give a new dimension into the sustainability of energy projects with a focus on empowerment, bridging the gap between aspirations and the choices available to beneficiaries. On the other hand the attempt is to suggest a coherent and comprehensive policy framework to fulfil these objectives and attain viability in their operations.

The current scenario demands a shift in terms of envisaging decentralised renewable energy (DRE) projects as a long term solution rather than a mere stopgap measure. It is highly unfortunate that a large number of the existing models lack such a long term operational sustainability. Such a situation exists due to a plethora of reasons ranging from weak policy support, ill regulated governance structures and the lack of proper maintenance mechanism. The paper tries to focus on these minute details so as to argue that regardless of the type of energy source, it is important to focus on widening the choices available for the beneficiaries while devising successful energy interventions.

Even when DRE systems have reached technical maturity and financial viability in remote areas; it is still lagging behind the attainment of aspirational parity[1]. The provision for an affordable option for moving out of the vicious cycle of energy poverty is to be made available on a high priority basis. This is the one single aspect that becomes important in the rural electrification scenario using renewables. The paper attempts to move beyond the existing indicators and frameworks while advocating for a rights based perspective in providing energy access through renewables. The framework is expected to be used as a decision making tool for designing government programmes, NGO interventions at the planning stage. Moreover such a framework can also act as an M&E[2] mechanism and programme analysis tool for donor agencies and financial institutions for ensuring the achievement of targets by various developers. Finally various policy and need based interventions have been recommended in order to use these framework for proper implementation and evaluation of these schemes.

[1] The idea that people's growing aspirations are to be met. The climbing up of aspirational ladder from simple lighting systems towards various productive and entertainment uses.

[2] Monitoring and Evaluation

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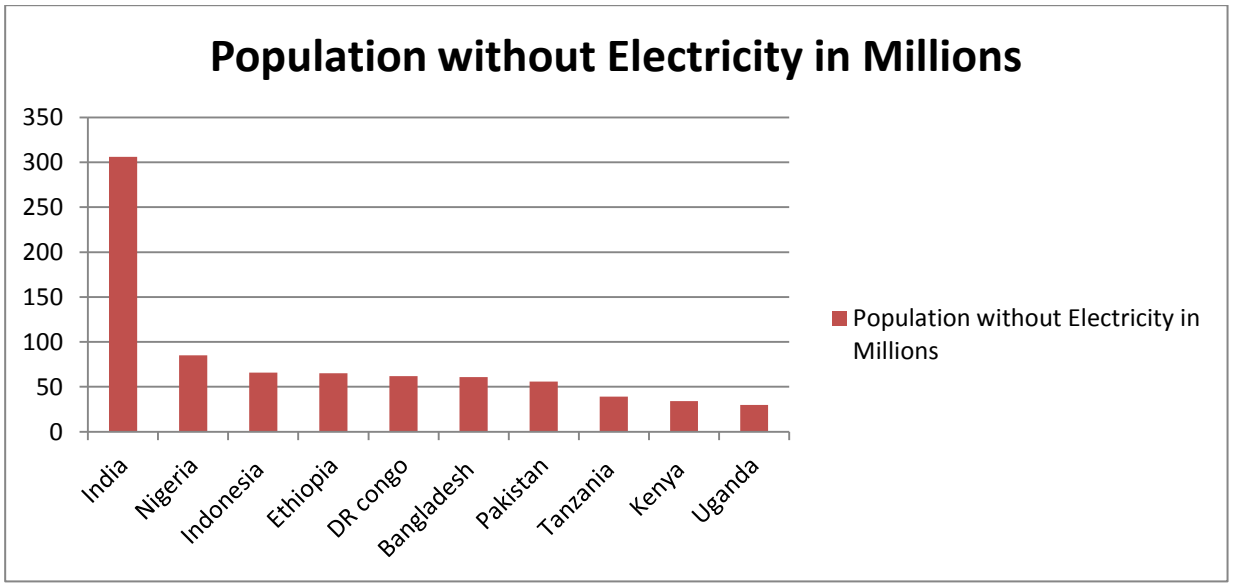
1. Introduction

The emergence of 'access to electricity' as an important ingredient in the development discourse is a recent phenomenon in the global context. Rather it is in nascent stages with on-going debates surrounding the correlations regarding energy and development. But vast literature on energy poverty and the field experiences clearly points towards the fact that electricity access is an enabler in creating decent living conditions (Smith et al., 2007) for millions of people around the globe.

For India, in its journey towards economic growth, an all-inclusive path needs to consider the aspect of electricity access while devising various strategies and programmes. The lack of such a focus has created a great deal of rural – urban divide in the country with a whole lot of issues including migration, unemployment, environmental destruction etc.

Figure 1: Population without Electricity, IEA 2013



The international statistics (IEA, 2013) on energy poverty clearly depicts that India with its massive population needs concerted efforts at every level to ensure a smooth development transition. At a certain level this has been attributed to a development dilemma of choosing a faster energy access path or a decentralized low carbon path. It also points out to the fact that the priorities and preferences of the target populations needs to find a place in the design process of various electricity access interventions. This is a crucial aspect while considering programmes as a long term solution for energy poverty moving from a mere stop gap measure. Decentralized renewable energy (henceforth referred to as DRE) technologies are expected to play an important role in bridging the *electricity access gap* by its flexibility to reach out to remote rural areas.

The paper tries to contribute to the dimension of '*empowerment of beneficiaries*' into the larger framework of the sustainability of renewable energy projects in rural electrification. An attempt has been made to include lessons from both literature review and field experiences while devising such a framework. The paper is structured in the sequence of discussing the broad scenario of electricity access and moving towards the specific case of rural electrification with a review of the electricity - development linkage. Having established this linkage the role

of renewable energy in rural electrification scenario would be discussed in the light of Indian experience with highlights of international best practices.

The report has the core aim of developing a framework for analysing DRE projects with the lens of empowerment as its central idea that includes various aspects from policy research and stakeholder consultations. In a way this framework would be applicable to various stages of development of DRE projects and also in the post project analysis. In the end the attempt has been to suggest possible mechanisms and policy choices required in moving towards such a comprehensive, bottom–up approach in achieving the larger goal of *'electricity for all'.*

1.1 Research Methodology

The research study has been designed with a mix of secondary literature review, policy analysis and interactions with various stake holders. Personal interviews and focus group discussions with the beneficiaries, developers and officials were carried out in order to capture the essence of the critical factors in the sustainability of the projects. The idea is to build up a checklist and model framework from the qualitative findings of the research so that the perspectives of the existing beneficiaries are given due importance while devising such a mechanism.

Various projects including solar home lighting systems, mini grids, and grid connected systems were covered in the states of Tamil Nadu, Karnataka, Maharashtra, Chattisgarh and Orissa. Such a vast field work has taken geographical variations such as forest areas, urban slums, remote tribal hamlets and semi urban locations. Diversity in site selection is expected to contribute a much more nuanced approach in developing the framework.

Table 1: Overview of Site Visits (See Annexe 1 for details)

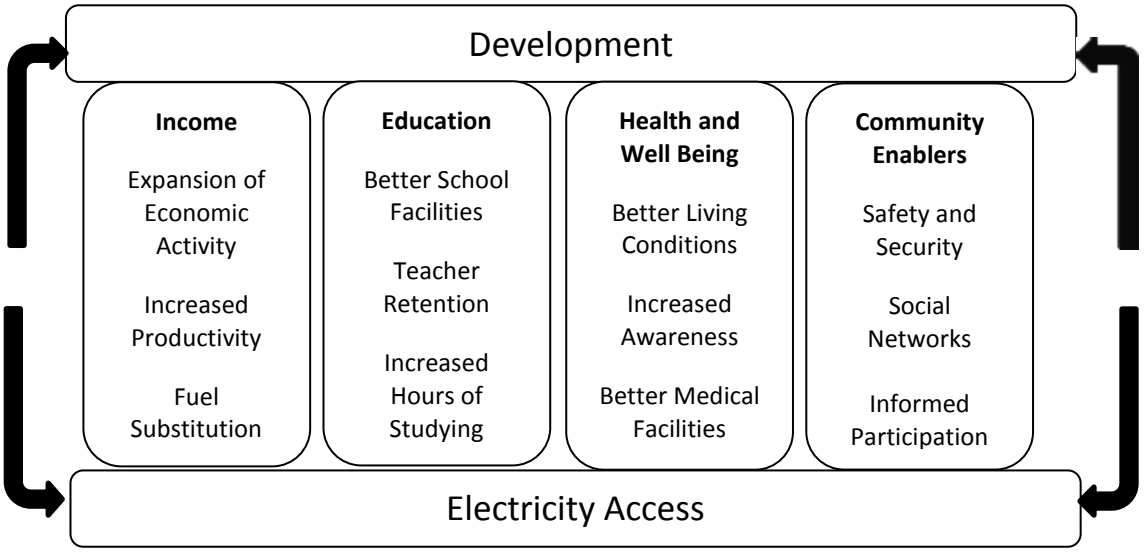
Sl No	Site Name	Type of Technology & Capacity	Organisation	Status/unique features
1	Hoskerahalli Slums , Bangalore	Individual Home Lighting systems	SELCO India Pvt Ltd, Bangalore	Proper Maintenance Mechanism and pay in instalments model
2	Agumbe, Karnataka	Standalone solar PV	Agumbe Rainforest Research Centre	Flexibility of RE in deep Forest areas
3	Ayyanadaipu, Tamilnadu	Solar Micro grid (890 WP)	TEDA and Minda Next Gen Power	Lighting and mobile charging
4	Darewadi, Maharashtra	Solar PV micro gird (10kw)	Gram Oorja Pvt Ltd , Pune	Well Maintained Properly sized system
5	Sirimane, Karnataka	Community Microhydel (4 kw)	Pico Jal Vidyut Samithi (Village committee)	Sustainable solution for ecologically fragile western Ghats

6	Uppukarame du, Tamil Nadu	Solar Micro Grid (890 Wp)	Jyothir gamaya scheme	Failed system due to lack of proper maintenance
7	Kalahandi, Odisha	Community microhydel (5kw systems)	Gram Vikas, Community	Community mobilization and participation
8	Ottainatham, Tamil Nadu	Biogas to electricity plant (3.5 Kw)	TEDA and village Panchayath	Pilot experiment with panchayath and SHG's cooperation
9	Thoothukudi, Tamil Nadu	Housing scheme with integrated solar lighting systems	Chief Minister's Green House Scheme, Govt of Tamil Nadu	integrating renewables in various government interventions
10	Rawan & Mohda Chattisgarh	Solar Micro Grids (4 kw and 7 kw systems)	CREDA	Undersized system but best maintenance practices

1.2 Electricity Development Linkage

It is an undisputed fact that electricity is an enabler in the path of development while helping people to move out of the vicious cycle of poverty. Off late this linkage has been acknowledged in the research arena and has seen its entry in to the programme design of various interventions. It is indeed a necessity that such an emphasis on electricity should capture a more visible space in development interventions especially the ones that are targeted in poverty alleviation.

Figure 2: The Electricity Development Linkage. Prayas Energy Group & Pune International Centre (2013)

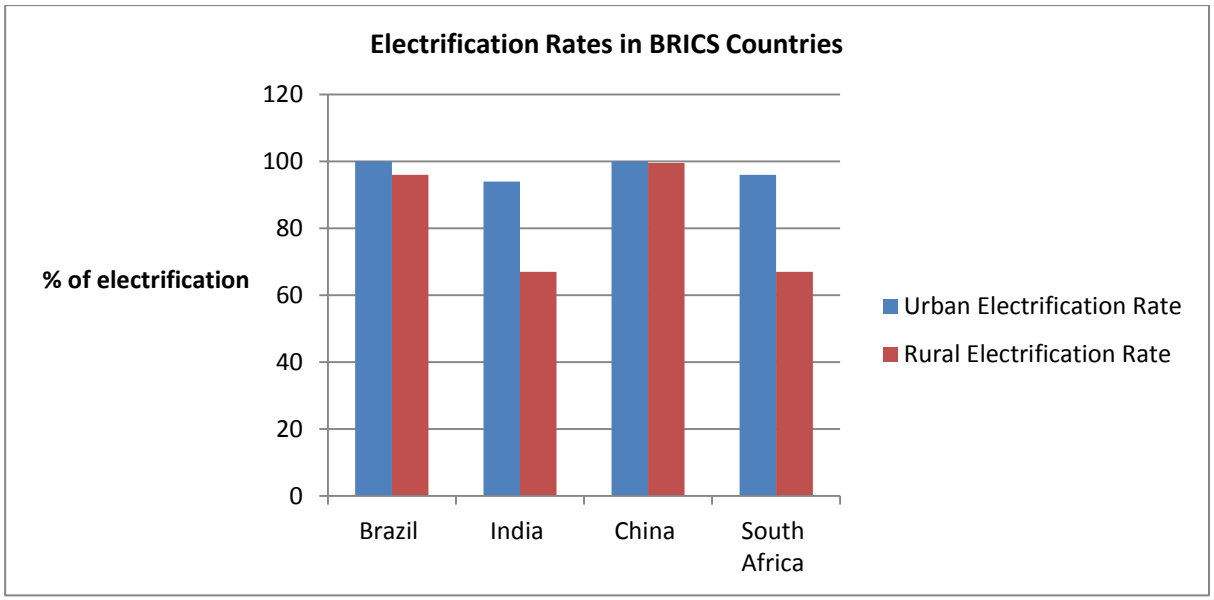


Having established the link between energy and development there is a need to decipher the entire discourse of development in this context. Normally the history of energy and development has emphasised on the aspect of energy access and its impacts on economic and social development. On many other occasions it has been deciphered as the climbing up of the *energy ladder* (from inefficient to efficient sources of clean energy) and thereby improving the living standards (Bazilian et al., 2010). This approach is indeed necessary but moving on to the neo energy framework[3] it is a fact that the development discourse has been shifted from mere development to the sustainable development scenario.

It is also important to note that the consumption of energy is not an end in itself. Increased energy use makes sense only if it can improve the quality of life (Reddy, 2001). So our current models of mere electricity access become a failure with little emphasis on actual level of usability for the poor consumers. In a way access to electricity should be envisaged as a poverty reduction tool and harbinger of social –economic development (Reddy, 2001).

2. Rural Electrification

India with 70% population[4] living in rural areas, electricity access becomes an integral and initial step in the process of promoting sustainable development. Lack of basic infrastructure, unemployment and low connectivity has been the major hurdles for progress in the rural areas. Electricity access can contribute in overcoming these hurdles with additional benefits of income generation and increased productivity. While considering the electricity development linkage it is quite clear that electricity can play an important role in enabling the beneficiaries to escape the vicious cycle of poverty. An analysis of the BRICS[5] countries in the case of urban and rural electrification rates reveals that India is clearly lagging behind other countries in addressing this gap.



[3] The assumption of energy services and sources being located in a larger framework of climate change and sustainable development

[4] Census Data

[5] Brazil, India, Russia, China, South Africa. The status for Russia is not available.

Figure 3: Rural & Urban Electrification Rates in BRICS, (IEA 2013)

Brazil and China, the two countries that are comparable to India in many aspects including population have actually addressed the issue of energy poverty quite aggressively as evident from the statistics (Ref Figure 3). In India it is unfortunate that we have a massive rural –urban divide in electrification scenario which has adverse effects on an all-inclusive development and growth for the country. At this stage some serious corrections can be done in fixing our priorities and goals in connection with various interventions in this regard. The rural electrification strategies of these two countries can shed some light into the necessary corrections needed in the Indian context.

2.1 Lessons from International Experience: China & Brazil

Both these countries have shown rigorous and a well-planned system of rural electrification with proper coordinating mechanisms, incentive structures and a mix of various technological options. In a broader sense it is to be noted that there has been a mix of both grid extension and decentralized systems in the case of both these countries. In Brazil the constitution itself recognizes the importance of providing electricity access (Niez, 2010) to its citizens as a public service. In some sense the recognition of a rights based perspective in electricity certainly had an impact on accelerating the process of rural electrification. The process which started with the two broad programmes of *PRODEEM*[6] and *Luz No Campo*[7] (Niez, 2010) progressed towards a much more concentrated 'energy for all' program of *Luz Para Todos*[8]. 'Light for all' programme that started in 2003 took rigorous steps to provide universal access of electricity with the coordination of various government agencies. The focus on productive uses of electricity for integrated development and the idea of rural electrification as a means for poverty alleviation were the two success factors of this program that needs to be assimilated into the Indian context. The project that started with grid extension measures later used decentralized renewable technologies (Zeriffi, 2007) and finally achieved 96% electrification of rural areas by the year 2010.

The Chinese experiment of rural electrification relied heavily on decentralized options in comparison with the Brazil model. Even though extensive grid coverage measures were taken, a simultaneous development of local generation units was carried out using micro hydel, solar etc. The Township Electrification Program, Brightness Programme and the 'County Hydropower Construction of National Rural Electrification' were all based on decentralized RE (Niez, 2010) that were appropriate to the concerned terrain. Like Brazil, China also emphasized much on ensuring local development coupled with electricity access. This is to tackle the issue of low consumption in the initial phases along with the income generating activities improving the purchasing power of the poor households to pay the tariffs.

[6] Programa de Desenvolvimento Energético de Estados e de Município or Energy Development Programme of States and Municipalities was a government led programme started in 1994 with funds from National Treasury Fund.

[7] Light in the country side project in 2000, which allowed for special loans for utilities to carryout grid extension.

[8] Light for All.

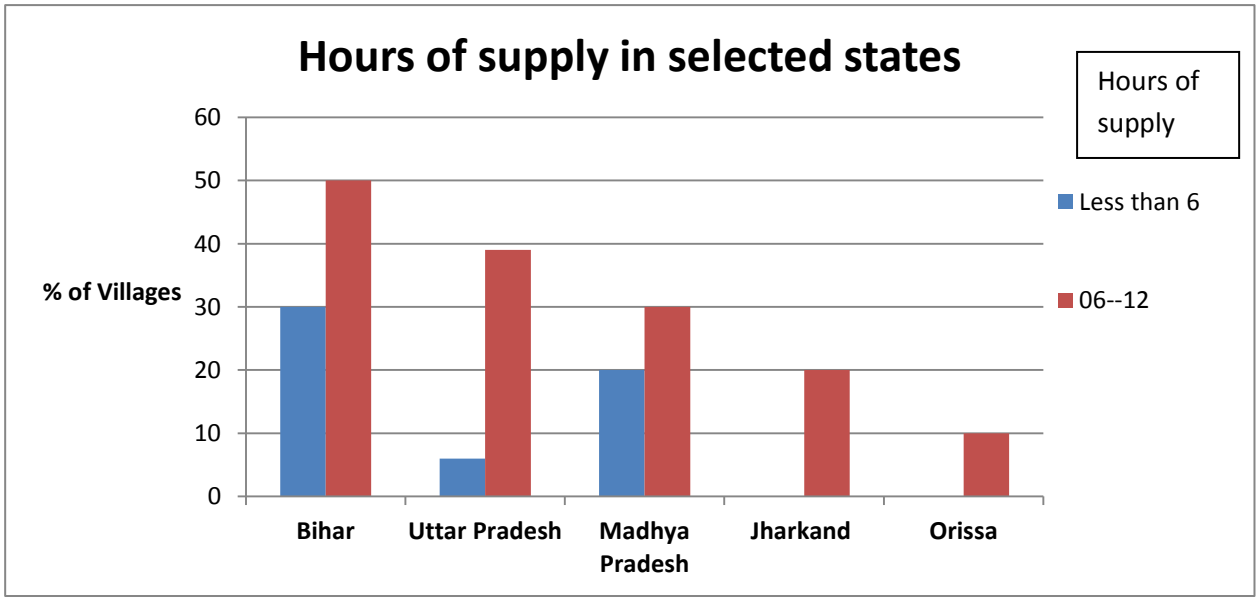
2.2 The Indian Scenario

Starting from 1970's various government programmes have been initiated in India with a target of providing electricity for all. Kutir Jyoti scheme (1988-89), Pradhan Mantri Gramodaya Yojana (2001), Accelerated Rural electrification Programme (2003) and Accelerated Rural Electrification of one Lakh Villages (2004-05) were the major initiatives in this regard (MNRE, 2012). In the policy sphere the advent of Electricity Act 2003 and the subsequent National Electricity Policy 2005 has opened up the second phase of electricity access measures in the country. The Rajiv Gandhi Grameen Vidyutikaran Yojana started in 2005 emphasized on massive grid extension while the Remote Village Electrification Programme supplemented these efforts with decentralized renewable energy options.

The rural electrification policy 2006 that envisaged a right to uninterrupted electricity supply proclaimed 'quality and reliable power supply at reasonable rates' as one of its stated goals. It also emphasised on a proper mix of decentralized and grid extension measures to achieve this goal. In the extremely remote areas *for villages/ habitations, where grid connectivity would not be feasible or not cost effective, off grid solutions based on standalone systems may be taken up for supply of electricity so that every household gets electricity* (REP, 2006). RGGVY has been successful in energizing almost 104070 villages as on March 2014 (MoP, 2014) with a fraction of decentralized projects under the Decentralized Distributed Generation scheme.

Moving over to the development paradigm under the comprehensive RGGVY scheme there is the provision of DDG which would cater to *the requirement of agriculture and other activities including irrigation pump sets, SME's, Khadi and Village industries, cold chains, health care, education and IT, This would facilitate overall rural development, employment generation and poverty alleviation (REP, 2006).* But in practice such a system was not followed in India unlike the experience of Brazil and China.

Figure 4: Quality of supply under RGGVY. (RGGVY Status Evaluation Report)



Even though RGGVY has created substantial impact in providing access to numerous households, there are some issues related to the present electrification mechanism. As seen in **Figure 4**, it is evident from the RGGVY evaluation reports that many of the villages still lack reliability of supply and should be covered under the DDG scheme for re- electrification. Meanwhile many of the already electrified sites lacks a proper metering and billing system which in turn leads to the issue of low collection rates. This combined with the failure of past projects of supplying highly subsidized and free cost electricity and then finding it difficult to continue the operation in a feasible manner (Cust, Singh and Neuhoff, 2007) has given rise to a situation where DRE technologies are expected to meet the energy access requirements.

2.3 Energy Access through Renewables: Critical Factors

Globally, decentralized renewable energy technologies have started to occupy a prominent space in the energy access arena. Focus on low carbon growth and climate change mitigation has reinforced the belief that renewables would play a major role in tackling energy poverty. Flexibility, ease of source availability, decentralized nature, emission reduction coupled with the fact that renewable energy is the backbone of modern and futuristic off grid systems (Reddy, 2001) (PPEO, 2010) is the reason for choosing it against the central grid extension efforts.

It is indeed true that DRE based systems would help in faster achievement of our energy access goals especially in the case of extreme remote locations and ecologically fragile areas. Various renewable systems including solar home lighting systems, standalone and mini/micro grid systems – biomass gasifier, solar PV and hybrid systems are used in this respect. A large chunk of such interventions are carried out by private players including NGOs, foundations and social entrepreneurs. It is highly appreciable that such efforts have benefitted millions of people in places where no government interventions have reached out. But in such a weakly regulated atmosphere it is important to assess the various issues and possibilities of using DRE in rural electrification.

2.4 SWOT Analysis

A typical SWOT analysis can reveal the current situation and future possibilities for the applicability of renewable energy technologies in energy access interventions. It is important to carefully analyse this landscape before we formulate the energy empowerment framework as it relies heavily on renewables to achieve the goals.

While analysing the strengths of decentralized renewable systems, it is quite evident that they have a crucial role in the future of energy access interventions. But it is equally important to rectify the inherent weaknesses and mitigate the threats so that the future programmes and policies would be successful. One of the major limitations of such systems is the failure to capture the growing aspirations of the communities. This combined with a lack of follow-up and maintenance systems[9] have resulted in the failure of many of such projects. It is also true that many a times such systems are not affordable (high tariffs on a per unit cost basis) and the poor people are made to suffer at the expense of low carbon growth.

[9] Interaction with community members in Tamil Nadu, Orissa (Details in Annexe 1)

Table 2: SWOT Analysis: Decentralized Renewables for Rural Electrification.

Strength	Weakness
• Decentralized • Suitable for access in extreme remote locations. • High level of innovation and competition.	• Inability to meet aspirations. • Lack of proper maintenance. • Uncertainties regarding grid interconnection. (Mini grids) • Low quality equipments. • High per unit cost for electricity.
Opportunities	**Threats**
• Low carbon pathway for future projects. • Linking RE with livelihoods • Promote Participation • Reduced dependence on central grid • Substitute for kerosene and controls household air pollution.	• Lack of proper regulation. • Multiplicity of interventions. • Lack of proper coordination among various organisations.

The existing regulatory and governance framework for off grid renewable energy projects is not properly developed and lacks clarity in terms of institutions involved. Uncertainties regarding grid interconnection and delay in disbursal of subsidies under various government schemes are the major challenges from a developer's perspective. Meanwhile creating a favourable ecosystem for the developers with proper incentives for innovation and competition can ensure the much needed private participation. From the perspective of communities, there is a need to shift our focus towards a more inclusive approach in analysing the process of empowerment that is happening as a result of energy access interventions. This is expected to contribute to the sustainability of such projects in addition to the usual techno economic feasibility frameworks for RE projects.

3. Energy -Empowerment Framework

Rural economic growth is inherently dependent on providing economically efficient, need oriented, equitable, self- reliant, empowering and environmentally sound technologies (Reddy, 2001). These aspects are extremely important to reach the goals of development via the route of energy access. Unfortunately there is a huge gap in the existing research and policy frameworks where the means of empowerment that captures all the elements mentioned above and crucial for sustainability of the projects is missed out while approaching the end goal of sustainable development.

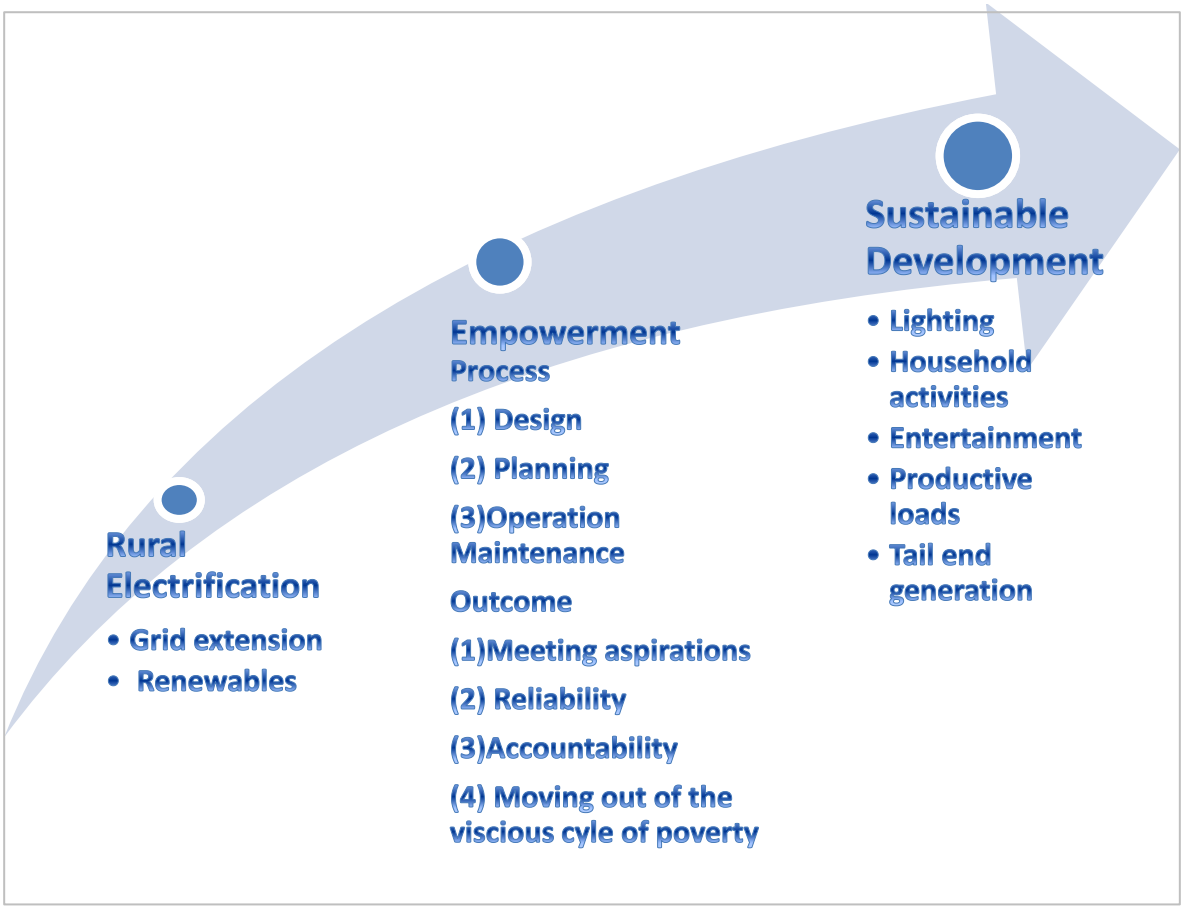
In a sense the idea of *Energy-Empowerment* integrates the human capabilities (Sen, 2000) aspect into the system of energy access. It actually moves beyond the claims of participation and ownership – the two major components of decentralization, shifting the priorities towards a choice based system for the beneficiaries. Such a framework by itself renders the beneficiaries a chance to choose what they would like to achieve from the provision of electricity access. This would necessarily mean that the enabler (electricity) would trigger a

shift towards comprehensive outcomes (where the process is as important as the end goal) than a situation of culmination outcomes that focuses only on the final outcome (Sen, 2000). In the context of implementation this would help to design a project where the beneficiaries (community) could appreciate the project for its actual utility in case of deciding various productive uses, income generation etc. In addition to this, such a framework can modify the existing tariff approach based on pricing electricity from renewables to match kerosene to tariffs that are comparable to the normal grid. Meanwhile on the monitoring and evaluation perspective a more nuanced approach in the analysis of the effectiveness of various projects can be administered using of this framework.

3.1 The rationale

In the case of energy sector there are very few indicators that capture the actual impact of these systems in the lives of people. A multidimensional indicator, EDI (Energy Development Index) was developed by International Energy Agency that captures the idea of impact of energy in lines with idea of Human Development Index (IEA, 2012). It focuses on separate country level data and community level data to analyse the impact of electricity access, clean cooking fuels and share of productive uses in total consumption of energy. Such a development indicator can be used for large scale country wide analysis using macro level data. Our idea is to create a multidimensional framework specific to renewable energy based systems (mini Grids and standalone systems) for rural electrification.

Figure 5: Energy Empowerment Framework- The rationale



In a sense this framework moves beyond the idea of EDI while dealing with various aspects of empowerment that can lead to the idea of sustainable development. Decentralized energy should shift the entire paradigm of sustainable development and energy access to the route of empowerment of the customer giving him a choice and proper service for which there is indeed a willingness to pay. In its rural electrification programmes, China has preferred to use a phased development through a bottom-up approach where local resources, and village level development and empowerment played an important role (Bhattacharya and Ohiare, 2012). Thus it is advisable to evaluate sustainable technologies in the framework of choice based empowerment rather than a complex framework of social and economic impacts.

3.2 Developing the Framework

Empowerment fills the gap between the enabler (electricity) and the final outcome (sustainable development) while making the outcome more sustainable and customer friendly. The basic idea of empowerment in this context can be mainly located in the works of Paulo Frierie (1973) and Cheater (1989) where in the term has been used both as a process and outcome which has an individual and a community component. We are trying to incorporate empowerment both as a process and outcome because of the type of framework includes both these components. For example, the increased participation in decision making denotes the process of empowerment whereas the economic self-reliance due to productive activities can be categorized under the mode of an outcome (Refer Figure 5). But the underlying factor is that both of them can be measured and converted into quantifiable terms using the micro level data of households which then would be aggregated to a community empowerment index adjusting for certain control factors like for example the proximity to decent infrastructure already in place which can rule out the direct link of electricity with these factors.

Such an index can be prepared for every project but requires proper data collection and analysis which can be done in a very controlled atmosphere where there are a lot of factors which can in turn affect the projects. Moreover the subjective nature of these perceptions and their qualitative nature can be a challenging situation for developing such an index. So the attempt here is to create the necessary framework for such an analysis that in an advanced stage can be converted into a micro level analytical index.

Table 3: The Rubik's cube for Energy Empowerment

Affordability	**Proper Service and Maintenance**	**Reliability**
Capacity Building	**Right to Energy Access**	**Aspirational Parity**

The Rubik's cube (Ref Table 5) of energy and empowerment scenario is primarily used in this context to capture the essential factors. It is devised as per the model of famous Rubik's cube game where all the 6 colours are arranged in particular fashion to achieve the objective of the game. Similarly all iterations in developing a project should be scored in accordance with the above mentioned 6 parameters that are identified as crucial in sustainability of the intervention. A win-win situation is achieved in prioritizing the various components and ensuring the co-existence of these parameters while planning, operation and evaluation of the projects. The framework for analysis is a necessarily a superimposition of the energy-empowerment framework and the Rubik's cube of energy. As a result the framework consists of factors which consist of both process and outcomes given below.

Capacity building

- Availability of locally trained technicians for repair and maintenance
- Participation in various committees (village electricity committee)
- Training and information dissemination activities for the beneficiaries
- Availability of manuals and hand-outs in the local language

Right to access

- Recognition of access and quality of supply as a right of the beneficiary.
- Enable promoting equality and non-discrimination within the community.
- Special consideration for women, children and marginalized sections.
- Choice of generation technology (for the community)

Affordability

- Regulation on tariffs
- Possible environment for grid connectivity which can reduce the tariffs
- Effective and transparent tariff collection

Proper O&M mechanism

- Guaranteed maintenance mechanism
- Mechanism for a proper ' Corpus Fund' for future maintenance activities
- Availability of equipments for maintenance
- Easy availability of energy efficient appliances (CFL's etc)
- Routine checks and local capacity building

Reliability

- Guaranteed supply hours (especially in the peak hours)
- Proper compliant redressal mechanism
- Tariff component should take into consideration reliability of supply also
- Proper back up system available in case of lean period (Monsoons etc)
- Proper framework for grid inter-connectivity in case of grid arrival

Aspirational Parity

- The project should enable people to widen their choices of energy use
- Efficient enough to support basic activities such a lighting

- Capacity for running productive loads
- Scope for extra income generation through diversification of works
- Suitable for enhancing information through entertainment and educational activities

From the field experiences it is clear that empowerment can be located in these parameters and the beneficiaries value these aspects that can contribute to the longevity of the project. Similarly within this framework there can be further division of empowerment in terms of long and short term targets. In a long run it can be argued that the process leading to empowerment can contribute to large scale changes in the existing social structures and enhance various capabilities in community members. But from the angle of tackling energy poverty, it is observed that the recognition of the beneficiaries as valuable customers becomes the single most important factor contributing to the idea of empowerment. The whole idea of developing various parameters has been devised keeping this aspect in mind.

This framework can act as a tool for analysing the effectiveness of various energy interventions. Moreover it is advisable to use such a framework more as a check list while planning such projects as the above mentioned aspects are actually crucial in the success of these projects (See Annexe 1). It is true that such a framework is completely from the beneficiaries' point of view, but care has been taken in terms of keeping the developers also in the loop so that their efforts are valued and acknowledged. It should be noted that we have not considered the case of cooking while developing the framework. Even though lack of clean cooking facilities has occupied a major portion of the energy poverty issue, we have confined the study to electricity so as to have a more focussed approach. Similar methodology can be extrapolated to clean cook stoves programmes also.

4. Policy Environment and the Way Forward

Based on the above mentioned framework it would be appropriate to analyse the current policy and practice environment so as to understand the entire energy access paradigm in terms of its effectiveness. The two way process of learning from the field and the policy could contribute to the much needed pathways for future project developments. The policy recommendations can be classified into three broad categories in terms of the level at which they are supposed to be materialised.

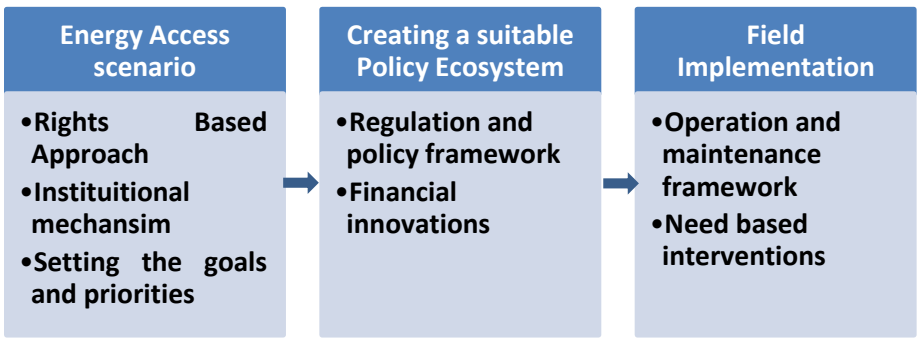


Figure 5: Flow of Policy Implementation

4.1 Rights based approach in Energy Access

In the development sector the importance of energy access is not acknowledged properly with lot of debates surrounding the energy and development linkage. In a way it is evident that this lack of visibility of the sector has been a major setback in bringing in an energy access revolution for millions of people around the globe. Off late there has been a paradigm shift towards energy access slowly gaining visibility in the global development platforms. Even though there is no specific goal for attainment of electricity access in Millennium Development Goal's, it is an accepted fact in the energy-development literature (PPEO, 2010) (Smith et al., 2007) that provision of electricity is inevitable in the attainment of the goals. Ban Ki moon, UN secretary general reinforced this idea while stating "Universal energy access is a key priority on the global agenda, it is the foundation for all MDG's. Without energy services, the poor are cut off from basic amenities. They are forced to live and work in unhealthy, polluted conditions. Furthermore, energy poverty directly affects the viability of forests, soils and rangelands. In short it is an obstacle to the MDG's" (PPEO, 2010). Such a shift in the development agenda should push the policy atmosphere to the idea of 'Right to Electricity'.

4.1.1 Right to Electricity

In India the idea of poverty has been largely associated with deprivation of basic amenities like food, shelter, drinking water etc. Many interventions by the government and NGOs have focussed on ensuring these basic provisions for the poor. Now the challenge is to create a visible space for energy as an enabler for providing these provisions. It is quite evident that providing access to clean water, health facilities, street lights for safety, and lighting for education needs proper energy interventions. The Johannesburg declaration on sustainable development emphasized that "*access to energy is a basic requirement for human dignity "(*Bradbrook and Gardam, 2006).

A human rights approach to energy can impose an obligation on state at both international and state level so as to respect, protect and promote this right (Bradbrook and Gardam, 2006). Even with in this broad energy context we need to differentiate access to clean cooking and electricity separately. We confine the discussion to electricity in this context. For example, to achieve the basic goal of providing safe drinking water to the poor would require at least one million water pumps for which electricity from conventional or non –conventional sources is necessary. Moving forward it is important that energy access prioritize the need for providing economically efficient, need oriented , equitable , self- reliant, empowering and environmentally sound technologies" (Reddy, 2001).This should capture the growing aspirational needs of the people into the framework which can materialize their choices in a long-term.

4.1.2 Gender and Energy

Non-discrimination and equality are the features of rights based approach in any intervention. In the energy context this calls for promoting gender equality through various energy based programmes starting from the design phase itself. Even though many studies conclude that achieving gender equality through energy access is less clear (Skutsch, 2005) there is a general agreement that energy access has given mixed results[10] such as

- Women carrying out their traditional roles more effectively with an increase in leisure time (Clancy, 2011)
- Men sharing household works after electrification (Clancy, 2011)
- Reducing transaction costs on information flows (Jacobsen, 2012)
- Promoting women empowerment (Skutsch, 2005)

Village electricity committees in some of the field sites had an active participation of women during their meetings. It was also observed that at times this has been translated to a situation where women were seen taking official responsibilities in the processes of such committees. But this was observed in very few exceptional cases and the general feel is that a drastic change has not taken place in promoting gender equality. A massive change in the gender space needs a complete transformation in the existing gender roles in the society. There needs to be an extra effort in this direction while devising specific programmes for communities. A complete integration of gender equality measures into the design of interventions and strong compliance mechanism for the same can be a desirable step in this regard. Already many of the international funding agencies have such a system in place which can be extended to the government programmes and energy specific interventions. In addition to this it is also advisable to take adequate steps to ensure that economical and socially weaker sections of the society are also getting consideration while developing such projects. Government policy documents and growth projections in the renewables space also can follow such a model without which empowerment through energy would be incomplete.

4.1.3 Shaping Post 2015 Development Agenda

When post 2015 agenda takes over the MDG framework, it is desirable that various entities in the energy and development scenario push for a strong representation and visibility of the sector in the global development agenda. Such a visibility is the first step towards securing more funds and expertise for the sector which can then tackle poverty and associated issues. For a developing country like India this translates into an appropriate push for low carbon strategy in tackling energy poverty. Presently our focus on low carbon growth and energy access as a simultaneous approach has failed in some sense with a lack of proper coordination between the Ministry of Power and the Ministry of New and Renewable Energy.

It is indeed appreciable that many of the existing policies have started recognizing the need for such an approach including Rural electrification Policy 2006 which clearly states its intention to provide "*consumers, particularly those who are ready to pay a tariff which reflects* ***efficient costs*** *have the* ***right to get uninterrupted 24 hours supply*** *of electricity"* which is then captured 'quality and reliable power supply at reasonable rates' as one of its stated goals. Moving

[10] http://blogs.adb.org/blog/power-energy-transform-gender-relations

further it is high time a focus to be kept on something like a right to energy in the country while clearly showing the linkages between energy and development.

4.2 Appropriate mix of Decentralized and Centralized Strategies

The new development agenda is primarily focused on the aspects of 'participation' and 'decentralization' as a part of its broad idea of inclusion. It is indeed true that such a focus has its own merits in the long run where the power of decision making is transferred to the hands of communities at large when it comes to crucial development interventions. In rural electrification scenario, while decentralized renewable energy is posed as *'the solution'*, a more balanced and moderate approach seems to be beneficial. A proper mix of centralized – (grid extension, grid strengthening, load management) and decentralized- (local generation, community involvement) seems to be the appropriate strategy (Ref sec 4.3.1). Even when the country needs to follow a low carbon path towards development, our priorities still has to be in providing electricity access to millions who are living in the dark. While discussing the possibilities of a scale up of DRE systems there should be an equal emphasis on scaling down the best practices of centralized management systems to suit the needs of the particular environment. This would include institutional reforms and proper management systems.

4.2.1 Institutional Reforms

The rural electrification Policy shows a clear path towards achieving the desired institutional reforms. The various sections in the policy envisages involvement of communities (sec 6: REP, 06) along with an increased emphasis on Panchayathi Raj Institiuons (sec 9: REP, 06) in the sphere of rural electrification. For effective implementation of these strategies there is a need to move towards a formalized institutional approach graduating from the usual village electricity committees which are prevalent in the existing decentralized projects. The merits of VEC's – Independent and community owned can be coupled with the possibilities of a more structured entity operating with the government framework.

The experiment of rural electricity cooperatives in our country has in some way failed to meet the expectations (Rejikumar, 2007) due to – (1) interference of SEB's (2) Lack of authority to fix tariffs and (3) and the lack of bottom-up approach. But it is to be noted that the international experiences of REC's has been promising with U.S having more than 800 such cooperatives and Palli Bidyuth Samithis in Bangladesh at one time offering 3.8 million service connections (Rejikumar, 2007). In India although the numbers of REC's have declined drastically, experiences shows that at one time they had household connection rates four times that of the villages served by state electricity boards (Iyer and Manisha, 2007). This points out to the need of a proper restructuring and clarity in roles of such entities for the future electrification strategies. The idea of tail end generation using DRE technologies and a proper grid integration structure seems to be the main area that has to be explored in this regard. In line with the U.S model of an apex body for such cooperatives can work in collaboration with REC and the concerned ministries.

Higher level negotiations can be done at the level of this body while retaining the proper bottom-up approach of cooperatives at the local level. This would ensure the merging of the goals and avoid multiplicity of schemes. Moreover the source of generation can be decided in

an appropriate manner whereas MoP and MNRE can assume the roles of supporting mechanism without interfering much into this sphere. Panchayathi Raj Institutions needs an emphasis on capacity building to take up the increased responsibilities. The apex body in consultation with CERC and state regulatory commissions can negotiate prepare tariff guidelines as per the tariff policy. The choice of generation source and grid extensions also would then be decided more from a need based approach than driven by specific agendas. It is desirable to promote standalone projects only in the areas which are extremely remote or where grid extension is not feasible. In short, formalizing the existing decentralized governance systems coupled with proper co- ordination of various centralized institutions would serve as the perfect institutional setup.

4.2.2 Community Empowerment- Changing Roles

The usual claims of community empowerment are concentrated on the ownership and participatory aspects of the projects. It also includes various decision making capabilities and strong social cohesion which is part and parcel of this process. But close examination of such aspects reveal that in short it is the benefits of an energy source of which ease of use is that which ultimately drives the demand as these are the factors people desire over energy access itself (DFID, 2012). Such a dimension could make us think twice about the actual ground level realities associated with community oriented projects in view of their long term sustainability and actual benefits to them. This would in some sense can be translated into a change of role for communities where they would be reviewing the quality of power supply and customer satisfaction which should lead to a more transparent and accountable compliant redressal mechanism. As per the REP 06 such a responsibility is vested on the district committees which can be executed with the help of community. Essentially communities should play the role of monitoring and evaluation mechanisms in addition to the aspects of ownership and participation.

In a long run it would tend to move towards a more participatory system in place which may not necessarily be an involvement in village electricity committees but an increased role in reviewing the government machinery. This would be possible only when the electricity access sector attains the rights based approach. Meanwhile Institutionalization of social audits and increased RTI filings related to the electricity infrastructure, quality of supply etc would follow this transition and is expected to become the backbone of democratizing the sector.

4.3 Setting the goals - Energy access and Renewable energy

Achieving the twin goals of electricity for all and a low carbon growth trajectory has reinforced the role of renewables in rural electrification. This has indeed pushed forth an agenda which propagates decentralized renewable energy as the ultimate solution for energy access. Even though there is clear opportunity for emissions reduction in the electrification scenario, it should not be done at the cost of pushing the entire renewable development in to the rural sector. Meanwhile most of the urban areas have untapped potential of rooftop solar and scope for energy efficiency measures which can lead to a clean growth pattern. The idea is to minimize the pressure on the centralized generation facilities by substituting it by decentralized means in industries and urban areas alongside the focus on rural areas. The

section of population who pollutes should be the ones who should follow methods to mitigate it or should pay the price for it. Unfortunately the reverse is happening in the country and the willingness to pay[11] calculations based on kerosene usage has captured the centre stage in the process of justifying the deployment of renewables in the country.

4.3.1 Grid extension versus Standalone systems

The aforementioned issues have thrown open a debate on whether rural electrification should be completely in the domain of decentralized renewable energy barring any chances of grid extension. Such a thought process has been reinforced citing the following reasons

(1) The unreliability[12] of existing grid (mainly under RGGVY).

(2) Lack of adequate loads.

(3) The comparative economical advantage of decentralized renewables over grid extension for extreme remote areas.

While these reasons are justified in terms of a short term vision for electrification, field experiences suggests that a reliable grid can be the most preferred solution over the intermittent and high cost renewables. The failure in providing reliable grid shouldn't find its solution in promoting a technology which is totally different in its properties and mode of operation. Then the focus should shift towards using micro grids as tail end generation units that can strengthen the grid while reducing the need for expensive storage systems and dealing with the intermittency of renewables. The standalone environment calls for a much deeper operation and maintenance framework, in the absence of which sustainability of the project can be in danger.

Moving on to the issue of load management, a certain element of growing aspirations is to be taken into consideration while arriving at critical conclusions around the same. In a way ground reality (see Annexure 1) points towards a scenario where households leapfrog from the initial low load scenario in shorter time periods than expected, causing the mini grids to collapse. In a similar way it is always advisable to run agriculture pumps, productive loads etc during low demand times to match the operation with solar, wind etc. Further an advanced strategy would be to use renewable energy technologies for specific purposes such as water pumps and mills so as to optimize their usage while removing the pressure on central grid. The specific case of solar pumps would be dealt in further sections with greater detail.

The comparative advantage of renewable energy technologies over grid extension is justified in case of increasing remoteness of the specific locations. But the normal urban experiences suggest that grid extension is a long term investment in itself which leaves the beneficiaries with a hassle free supply system. This in turn would lead to a situation where the planning process should identify such extreme remote locations which are not to be electrified under grid extension. The remaining set of unelectrified/poorly electrified areas can have mini grids but with a clear vision of grid interconnectivity. Otherwise there would be an issue of equity if those areas are left out while extending the grid. On the other hand the lack of clear vision at this stage would place the developers in a situation of uncertainty if the beneficiaries choose to

[11] http://re.indiaenvironmentportal.org.in/blogs/are-grid-solutions-really-more-expensive-rural-poor

[12] Hours of supply less than 6 hours

migrate to the grid in the future. Our idea should be focussed on creating a win –win situation for the aspirational needs of the poor and the commitment of the energy provider who intervened in a space where government mechanism has failed miserably. International experiences also suggest that the success of grid extension approaches is dependent on the right set of political imperatives (Dubash, 2007) than anything else which is quite evident in the context of South Africa.

4.3.2 Environmental considerations and Low carbon Growth

One of the major aspects which need specific attention while devising policies related to renewable energy and rural electrification is the location of the sites in fragile ecosystems .In remote locations and forest areas if proper technology and capacity along with an assurance of maintenance is carried out then DRE technologies proves to be the optimal solution for electrification. In such a situation the zoning of areas into different slots in accordance with their relative remoteness and extend of forest clearance needed would help in devising optimized strategies to choose the type of technology and scale of operation.

The policy framework can actually incorporate these zoning aspects into consideration. This is important from the point of view that forest clearances by the ministry of forests and environment becomes a crucial part in the process of bringing in energy access to these areas. With the on-going debates about Kasturirangan committee report on the Western Ghats, the construction activities in these highly eco sensitive zones are to be brought under strict supervision. The official 'no-go' zones should be mapped beforehand and accordingly the type of technology (wind, solar and micro hydro) can be fixed. In the Western Ghats[13], we have previous experiences of micro hydel plants violating the norms and taking advantage of the label of renewable energy. This issue can be solved by a proper planning of these zones with the most desirable intervention taking into account the issues of availability of space, costs, extend of destruction to forests and bio diversity.

4.4 Regulation and Policy Framework

The decentralized renewable energy (DRE) space has now been occupied by wide fora of actors including NGO's, government agencies, independent power producers, and social entrepreneurs. There is a great deal of confusion with regard to the status and location of the existing DRE projects in the country. The space is highly unregulated with lack of co-ordination between various government mechanisms. At this juncture there is a need for a proper regulatory framework for the DRE interventions in the country. But this framework should act as an enabler and catalyst rather than becoming a hurdle for the projects. Creating a system where there is a win- win situation for both the developers and the beneficiaries would be a tedious task but not impossible. Such a situation can be created only when we adopt a light handed regulatory approach.

4.4.1 Light Handed Regulation

[13] http://www.thehindu.com/news/national/karnataka/minihydro-projects-still-a-major-threat-to-western-ghats/article4740215.ece

While moving towards a regulatory approach the assumption is that we follow a ladder approach where mini grids with grid interaction would be the major player. Thus the framework would necessarily deal with mini grids-both standalone and grid integrated as leaving electricity access sector to private parties in an under developed regulatory environment is not an appropriate option for rural electrification (Panda, 2007). On one hand we are talking about regulating a group of self – motivated entrepreneurs and voluntary organizations who have provided the first ray of hope to lakhs of villages where there was little or no government intervention. At the other end of the spectrum we have communities who are paying extremely high tariffs (based on willingness to pay in comparison with kerosene) to get access to their minimal loads and are prone to exploitation in case of a lack of awareness. Only a carefully thought out light handed regulation could be the answer to this regulation dilemma. The aspect of a light handed regulation (Tenenbaum, 2014) should be able to capture the entire system thereby creating a win- win situation for both developers and the community.

Light handed regulation should primarily focus on the process of 'registration' of an intervention with the government authorities rather than a complex regulation method. In a way the framework proposed here is trying to recommend a formalized process of regulation which can facilitate smooth operations for the developer that in turn leads to better service facilities for the beneficiary. The regulatory framework can effectively support a proper tariff mechanism and ensure protection for the developer in case of grid extension. The regulator can also play an important role in determining the appropriateness of the technology, sizing etc that can have impacts on sustainability of the projects and in deciding proper subsidy mechanisms.

Table 4: Benefits of Regulation, Compiled from Mini Grids for Africa, World Bank Group.

Mini Grid owner	Communities
A simple registration process which should be free from long procedures and bureaucratic hurdles.	More formalized approach in getting energy access.
Single window clearance mechanism for necessary approvals and subsidies.	Affordable tariffs even though it would be on the higher side in the initial period.
A separate regulator if necessary which can work in support of exiting regulators.	Assured quality of supply
Mechanism for looking after all technical, commercial and process decisions.	A clear idea on roles, responsibilities and compliance mechanisms.
Guaranteed protection in case of central gird extension and guidance for grid interconnection	Community owned projects also can continue as distribution entity even when

and tariff mechanisms.	it is grid connected.
Assurance of slightly higher tariffs considering social impact and effectiveness.	Increased participation of VEC's and community in a regulated environment.

4.4.2 Promoting Tail End Generation Models

In a way a community owned (localised) generation unit can be the model for the future grid strengthening measures. In India sparing some 20,000[14] villages, the rest is supposed to be grid connected in the future and in many places extending the grid has been proved successful in rural electrification. If our priority area is energy security then extending the grid and promoting tail end generation becomes important with a much larger say for communities than standalone systems. So the existing mini grids can be promoted as tail end generation models without which our energy access paradigm would promote standalone systems as a means of empowerment but would remain non competent in a long run.

The issue with current BOP[15] model is that the focus is on products rather than infrastructure. It is surely a stop gap measure in some sense but our long term goals are to be in line with the aspirational context of the beneficiaries also. So it becomes important that the regulatory environment should use the expertise of private sector in delivering the necessary infrastructure with a long term vision. Empowerment is highlighted at this point where clean generation bases are set up in rural areas and with a grid connected supply which can offer backup power and also helping to get away with storage related issues. Such a model is desirable for cities also where we can think about resident welfare associations and collectives promote small scale generation plants. This can lead towards evolving a proper democratic and choice based generation for various entities.

4.4.3 Better RPO Compliance Mechanism

The RPO mechanism stipulated for each DISCOMS are not met properly in the present situation (Greenpeace, 2013). The registration and recognition of various grid connected mini grids can act as a source for various DISCOMs to comply with their stipulated targets. When such compliance mechanism is made stringent, grid interactive systems makes sense for both communities and the utility. The situation now clearly indicates the scope of such generation models to help meet the RPO targets in future without much difficulty. The state regulatory commissions can play a proactive role in promoting such initiatives that have long lasting impacts on the renewable energy expansion in India.

4.5 Financing Option and Subsidies

The high capital costs has been one of the major issues related to the idea of renewable energy based rural electrification systems. Proper government intervention is needed to tackle this

[14] MNRE estimates the number in between (20,000-25,000)
[15] Bottom of the Pyramid- catering to the poor households

situation. A combination of innovative financing schemes and policy support would lay the foundation for such a support.

4.5.1 Dedicated Funds for Energy Access through Renewables

In some ways it is a sheer injustice that people living in rural areas are made to pay extremely higher tariffs even when their counter parts in cities enjoy uninterrupted power supply at lower tariffs even for their luxurious consumption patterns. The high capital cost of renewables in rural areas should be covered by creating a dedicated 'energy access fund' by levying a surcharge on the urban consumers. The idea in some sense is practised in states like Gujarat and Chattisgarh[16] where such money is used for rural areas.

There should be clarity regarding the collection and utilization of national clean energy fund and projects under various government schemes. The benefits for various projects under Clean Development Mechanism should be made available without much operational lags and interferences. Government agencies should play a more proactive role in guiding and creating awareness among various stakeholders in obtaining these benefits. The proposal to install 10,000 solar PV systems by MNRE with NABARD is a welcome move in this regard with a grant of 2.28 billion from NCEF. (Renewable Watch, 2014)

4.5.2 Subsidies and Financial Innovation

The design of subsidies is an important aspect of financial intervention in the renewable energy sector. Being a high capital cost system, at some point proper subsidies or viability gap funding mechanisms becomes inevitable in this context. The ideas of generation based subsidies or incentives based on performance (which has already been incorporated in large projects) can be one of the major elements of the financial support system. We can also expect the diversion of existing subsides on kerosene and diesel into the renewable energy sphere. But proper care is to be taken while devising these systems as in some cases the idea of high subsides has proved to be a hindrance for low costing options and innovations (Shah et al., 2014) as evident from the Rajasthan solar pump scheme.

The lags in disbursement of subsidy amount have also been a big issue from the developer's perspective. MNRE has reportedly not been able to pay subsidies amounting to around R.S 10 billion to the developers due to reduced budgetary allocations and rapid sector growth (Renewable Watch, 2014). Innovative financial mechanisms such as conditional cash transfer, voucher systems and output based payments which have been experimented in Nepal[17] can also be tested in our country as a pilot initiative. In order to ensure proper tariff collection, developers are now experimenting with prepaid metering systems in case of various energy services. Various mechanisms such as fixed instalment schemes have been incorporated by various developers so that the services are affordable for their consumers. It is also observed that the financing schemes offered by Regional Rural Banks (RRB) have facilitated banking services for poor people in extreme remote areas. Government programmes should recognize this favourable ecosystem created by energy interventions on the road to financial inclusion.

[16] Urja Vikas Nidhi, Presentation by Chattisgarh Renewable Energy Development Authority 2013.

[17] http://www.snvworld.org/en/sectors/renewable-energy/news/snv-pilots-innovative-finance-for-renewable-energy-in-nepal

4.5.3 Tariff Mechanisms

The light handed regulation which we have discussed above should make proper mechanism in place for a tariff mechanism which is affordable for the consumers and at the same time making financial sense for the developer. One of the ways to strike this balance is by incorporating an element of social impact in the tariff. This can be done by creating a comprehensive framework consisting of various social benefits, remoteness, effectiveness of compliant redressal mechanism, willingness to pay etc. As a regulatory body is in place the tariffs would be justified and can avoid any unnecessary exploitation.

4.6 The O&M Framework

Many of the off grid projects in the country are facing a major setback due to the lack of a proper operation and maintenance system in place. This is attributed to the

- Lack of availability of technicians in remote areas.
- Lack of awareness among the beneficiaries.

An effective O&M is expected to be the most cost effective method for ensuring the reliability and safety of an off grid project (Sullivan et al., 2010). This would include creating a proper system in place for maintenance and developing adequate human resources for the same.

4.6.1 A system for Maintenance Practices

Even though various government policies emphasize on carrying out routine maintenance practices there is little clarity surrounding the compliance mechanism and procedures to be carried out. This calls for creating a proper checklist and appropriate mechanism for specific projects to ensure its sustainability. Each project should be accompanied by a proper scheduling, procedures, required manpower and optimization to carry out the maintenance mechanism.

Table 3: Maintenance Practices, U.S Dept. Of Energy

Reactive maintenance	Preventive maintenance
Normal system maintenance in practice. Low cost In response to specific issues	Advanced time based systems to detect for degradation Increased costs due to investment in diagnostic equipments
Predictive maintenance	**Reliability centred maintenance**
Actual measurements to detect the onset of degradation Highly advanced equipments needed Manpower should be available locally	Highly organised system prioritization Optimization of activities are carried out in advance Needs a proper skilled maintenance staff

For the various cost considerations and the expected ground level implications it is highly recommended that we could move towards a preventive maintenance system from the existing reactive maintenance system. The increase in costs at the initial period can be justified by the benefits created during the entire life cycle of the system. The general trend of reactive maintenance system has proved to increase the costs and has adversely affected the longevity of various projects.

One of the biggest issues regarding such projects is the lack of locally trained technicians. This can be successfully tackled by ensuring that with the commissioning of project there should be provisions for the collection of 'corpus fund' and measures to form cluster level technician's group so that there would be knowledge sharing, routine maintenance which can prevent bigger technical issues. There are already examples of such systems in Chattisgarh under the solar micro grid projects of CREDA (Chattisgarh Renewable Energy Development Authority) where the technicians play an important role in ensuring the proper maintenance and thus the sustainability of the project.

In the CREDA model there are village level operators who are trained in basic operations and maintenance. They are also supposed to take the day to day readings from the system and are supposed to report to cluster level technicians looking after 2-3 villages. The overall system is supervised by technicians from CREDA visiting the sites once in a month to ensure the operations properly. In a similar way SELCO (case study 1, see Annexe) has also created a quick response maintenance system with a network of operators who provide fast maintenance services which ensure that the beneficiaries are getting serviced as valuable customers. This is an important aspect of consumer empowerment and has contributed much to ensuring the longevity of the system.

4.6.2 Creating the human resource base

It is indeed appreciable that the MNRE's HRD plan document talks about capacity building at various levels in imparting renewable energy based training. For our specific rural electrification scenario a focus on local capacity becomes important. The regulatory framework and various policies for renewable energy based interventions should include the component of local capacity building and mandatory provisions to ensure proper maintenance and follow up, without which the entire idea of decentralized energy would be a failure. This can have implications on women empowerment and employment generation if people from such location itself are trained to operate and maintain them. In Kalahandi district of Orissa, our field assessment has shown that people want youngsters from their own villages to be trained as technicians so that they would get better service at their doorsteps. The experience of barefoot college[18] in Tilonia points to the fact that illiterate women from rural areas are transformed successfully into 'barefoot solar engineers'. The potential of so called 'green jobs' in the country can be tapped by creating proper training facilities for the same which in a way would mitigate the unemployment crisis.

In addition to this government programmes on skill development can include the aspect of creating a workforce for renewable energy which is competent enough in installing and

[18] Barefootcollege.org

maintaining the projects. The already existing institutions like National Skill Development Council can include the energy portfolio in its fold so as to create a world class work force. Various livelihood programmes[19] of the central and state governments can also promote energy based livelihoods interventions through their targeted programmes. In Bangladesh, the Rural Electrification Board (Annabel and Heather, 2010) undertakes training of manpower for O&M through the Palli Bidyuth Samithis which creates employment opportunities and various electrification master plans. In short specific focus has to be given to the human resource development in renewable energy in the country which should be executed on a high priority basis.

4.6.3 Tackling Asymmetric Information Problem

Many a time the beneficiaries are not aware about the various provisions in the maintenance contracts along with the central agencies contracting the maintenance works to incompetent private organisations with insufficient manpower. A strict compliance mechanism needs to be developed as this would ensure that the terms and conditions in the maintenance contract are followed.

The provisions for hand-outs and flyers regarding maintenance best practices in the local language with pictorial representations would enable people to tackle the issue of information asymmetry and is expected to equip themselves with necessary knowledge about the system. Basic information like refilling distilled water in batteries, cleaning solar panels etc can be of great help in reducing the costs on frequent maintenance activities. Local assistance in the form of SHG's and panchayath mechanism for regular maintenance can act as an extra support. This in turn would increase the scope of availability of 'green jobs' by engaging the local population with in the loop of maintenance and follow-up. Renewable energy projects thus become an enabler in creating employment opportunities keeping a check on migration.

The chief minister's solar greenhouse scheme in Tamil Nadu directs TEDA to train the Panchayath Presidents, Secretaries and selected SHG Members for the aspects regarding the solar power system. A manual and hand out on do have and don'ts in the system are provided for the beneficiary. Moreover a dedicated call centre has been opened for the households to register their complaints. In our country panchayath officials and ward members do play an important role when it comes to the dissemination of the benefits of various schemes to the end users. A proper integration of this sort is highly recommended if energy access through renewables has to be successful.

4.7 Solar Pumps and Need based Interventions

One of the major advantages of renewable energy over centralized systems is the flexibility of the former in regard to various end user applications. In the rural electrification scenario this can be attributed to the use of intermittent renewable energy technologies where the supply and demand match without the need of expensive storage systems. The use of solar pumps is such an intervention which makes much more sense in rural areas where the pressure on central grid is reduced and substituted by them.

[19] National Rural Livelihoods Mission and National Urban Livelihoods Mission

4.7.1 Promoting Solar Pumps

In rural India there is a large demand for agriculture pumping system with a lot of subsidized power being supplied in this regard. From the carbon emissions point of view, lack of grid stability has seen the increased use of subsidized diesel for running these pump sets that has aggravated carbon emissions. There is a clear correlation between increase in electricity use and productivity rise in agriculture (Bhatia, 1999) (Singh, 2009). At this juncture Department of horticulture, Government of Rajasthan has successfully initiated a solar pump programme for 10,000 farmers with a subsidy component of 86%. Such an intervention has increased productivity, helped in savings up to R.s 60,000/ year/farmer in some districts (Shah et al., 2014).

Moreover this points out to the fact that solar power can be used effectively for need based interventions rather than pushing for a complete renewables based electrifcation system. Converting the existing pump sets to run on solar power is expceted to compensate for the load management in the mini grid installations while ensuring reliable supply for the villages. The diversion of subsidies from kerosene and diesel coupled with the feeder separation methods is expected to take off such a revolution in the immediate future. Meanwhile community based user groups can keep a check on the usge of groundwater which would help in reducing the overuse of water in the case of solar pumping.

4.7.2 Integrating the Energy Component in Government Schemes

The chief minister's solar powered greenhouse scheme in Tamil Nadu is a pioneer in regard to integrating the scheme of housing for BPL families with solar home lighting facilities. The project that started in the year 2011 plans to build 60,000 houses each year till 2016. A first of its kind government housing scheme in the country which has a dedicated solar lighting programme integrated into it. The houses are also provided with grid backup and when the net metering policy of government comes into action they can sell excess power back to the grid also which is a true sort of empowerment for the people**.** This points us to the importance of having more such innovative schemes from the government which has a mix of components rather than interventions for achieving mere numbers in megawatts. It is advisable to have schemes for solar pumps for irrigation, PHC's in tribal areas run on solar, schemes for lighting schools etc as when such interventions are required.

4.7.3 Demand Side Management

In India even after having an 'Energy Conservation Act' in place the energy efficiency measures has received little attention while talking about the energy access systems. We are yet to reach the 'Negawatts instead of megawatts' approach proposed by Amory Lovins. This has had a huge impact on the existing intervention in the sector both in rural and urban areas. The idea of rural electrification is not only confined to the specific interventions but should be coupled with the benefits of energy efficiency measures in urban areas. The money saved by using energy efficient appliances or the compensation fees that can be applied in the absence of such appliances can be used for financing renewables in the rural areas.

Most of the rural electrification programmes using DRE insists on using energy efficient CFL's and LED's. But a lot of awareness is needed in this regard so as to impart a complete understanding about the energy savings in such areas. In remote there is lot of difficulty in procuring such efficient equipments once they are to be replaced. Many a time the experience shows that people revert back to incandescent lamps[20] which are cheap and easily available. Governments and various other organisations can come up with specific kiosks in order to tackle this issue. Integrated energy centres that house various equipments and accessories pertinent to renewables can be created in various clusters for easier accessibility for the consumers. Renewable energy development agencies of various states can take a lead in this regard with appropriate tie- ups with other private partners.

5. Conclusion

India is in its journey towards achieving the goal of high economic growth. Various programmes have been designed to enhance the productivity of different sectors in the country. It is also important for our country to adopt an inclusive path while striving for this development. Historical evidences suggest that our story of development has also been of displacements, rural –urban divide and discrimination. It is important to note that we have to tackle the issue of poverty from all angles so as to cater to the needs of the millions of people who are caught up in the vicious cycle of poverty.

The field observations have clearly shown that certain basic aspects have to be emphasized in order to create a favourable environment for renewable energy to become successful in rural electrification. Proper care has to be taken while selecting the type (Mini Grids/standalone/grid tied) and scale of technology for various settings. Ensuring the availability of local technicians and creation of proper 'corpus Funds' for future operations are two of the important aspects related to the sustainability of decentralized energy projects. Above all, empowerment can be seen as a product of customer satisfaction combined with participation and voice when it comes to energy interventions. It is high time we recognize the beneficiaries as valued customers so as to render proper services to ensure sustainability in operations. Only an approach of this sort can be successful in a long term.

The paper has tried to incorporate the importance of electricity access as an important element in tackling poverty. Such an effort is expected to put the sector in the high priority list so that various interventions in cross cutting sectors become efficient in its delivery. For example a common development intervention of providing drinking water can be made effective with the use of proper pumping systems which can be run on electricity. Considering the current scenario the importance of renewable energy in terms of electricity access has been highly valued. This has been the major motivation for coming up with such a framework. Such an attempt has been made with the expectation that new projects which are in the pipe line for rural electrification would consider the proposed recommendations while implementing them. It is also expected that various organisations would take up the initiative

[20] Field experiences in Orissa and Karnataka.

to use these framework for their M&E aspects of projects. At least a change in the thought process of such implementations would be considered as a positive outcome of this effort.

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Annexe 1: Case Studies

1. SELCO, Bangalore

The migrant labourer’s colony Hoskerahalli slum in Bangalore were not getting power from the grid as they live in temporary tents and migrate to different parts of the city according to the construction sites they work. This makes the use of solar energy feasible for them than the normal gird. Most of them belong to northern Karnataka and have their children studying in their villages. So their needs in these settlements are mainly limited to lighting and mobile

charging. They can also carry these panels along with them to whichever places they go. In short for them renewable energy is flexible and customized.

The two settlements here constitute almost 60 households in which almost 21 of them possess the solar lighting systems. The system provided by SELCO consists of a single solar panel, battery, controller unit, one led light (which consists of 3 blocks of lamps for bright light). They can buy these units with a flexible monthly instalment scheme which is being collected by special collection agent. This eases out the financial burden on them and by owning these units it clearly creates the need to maintain them properly contrary to the freely distributed systems in many of such slums.

Each household pays R.s 1000 as a lump sum in the beginning and R.s 500 per month in instalments till the total amount of 6000 is reached so as to own the unit. In return they are provided free maintenance and regular checks by the operators of SELCO. The social enterprise has created a very good network of technicians at the local level that the system failures are checked and maintained efficiently.

The people here were previously dependent on kerosene for lighting that would cost them almost 300 R.s per month for kerosene as they had to buy it from outside the public distribution shops which is almost 70 R.s / litre. In addition to this they had to spend R.s 5 for charging mobile once in the nearby shop. It is also worth mentioning that here most of them use their mobile phone as flash torch and radio also. This gives us an interesting picture of how the solar units have empowered the households by lighting their lives and enabling them to charge their mobiles without any external help.

The use of LED lights in the place of kerosene lamps has certainly impacted the lives of people. With the use of these LED lights they are having access to decent and efficient light from 6 pm in the evening to 6 am in the morning and don't have to worry about any electricity bills. In poor households the switch from kerosene lamps to solar powered LED lighting is in itself a great achievement when we come to know that a recent study observed that India has an alarming high rate of household air pollution compared to the WHO standards.

As most of the inhabitants here work as construction labourers there are no such direct uses of lighting for livelihood activities in a major way but still there was the example of a woman who was carrying out stitching and embroidery works who uses the light so that she can work late in the night and earn extra income and do some urgent works for her customers. This can be a model replicated in such projects where there is an enhancement of livelihood activities other than productive loads, where the lighting systems itself acts a component for enhancing livelihood options. Here the innovation in the design of these customized lanterns helps in achieving that objective.

2. Sirimane - Community Micro hydro

Sirimane village in Chickmagalur district of Karnataka in the Western Ghats area is famous for its Sirimane falls which attracts lots of tourists from various parts of the

country. The mountainous area is sparsely populated and the houses area scattered with some plantations in between. The peculiar geography was a big hurdle for conventional grid to reach there but under RGGVY the area is now electrified. But the power supply is erratic and as per the villagers they get power only for 6 hours a day and there are frequent voltage fluctuations throughout the day. In 2003 when the village didn't have grid electricity, they came up with a plan to produce electricity from a Pico hydel plant of 4 Kw which could cater the needs of the houses which previously didn't have access to any power.

PICO Jala vidyut yojana anushtana samithi, a registered society was formed in order to carry out the project with the technical help from TIDE, Bangalore. The project is now run by the jala vidyut samithi (village electricity committee) and is operating successfully catering to the needs of 10 households and a school.

The samithi has fixed a tariff of R.s 100 per month from each household and the power is supplied free of cost to the school and the operator who is from economically weaker section. Initially the project cost of R.s 4.7 Lacs was shared by the villagers by pooling in 30000 R.s / HH and a part of it was sponsored by the sringeri mutt trust .major chunk of the funding was carried out by INEP(Indo –Norwegian Environmental program) administered by the Dept. of forests , Government of Karnataka.

The project is maintained by the VEC which has a member each from the 9 families who are the beneficiaries of the project. The committee meets at least once in 2 months or whenever there is an emergency situation. Sri Laxminarayana Bhatt is the present president of the samithi. One of the major success factors of the project is that the location of the project is in such a way that they get water all the year round. This heavy rainfall area ensures that they get decent and adequate flow to run the hydel plant throughout the year. The proper maintenance is one of the major success factors for the project. The local technician (Srikant) has been trained to carryout minor maintenance operations. If any major repair is needed then the project engineers and technicians from the company is contacted (Bangalore). This factor is an important aspect which every such micro/mini grid should follow as many of similar projects in Orissa and Kerala are non-operational as timely repair is not carried out. The training of local technicians and favourably someone from the community itself can be an added advantage for the sustainability of such projects. Routine checks are also an important part of this exercise which can correct some minor mistakes which would lead to huge damages in future. This has to be incorporated in the planning phase of the projects itself and should find a space in the mini grid policy. All over India irrespective of the type of technology used the proper plan for maintenance has played an important factor in the sustainability of the projects. It is also advisable to create a cluster model or network of local technicians for such projects in these areas. They can be given training in all the aspects of such projects and will work as a platform for knowledge sharing. This would help in decentralizing the entire aspect of renewable energy generation at the same time ensuring stability and energy security**.**

The project provides electricity supply from 6 PM in the evening till morning and then switched off at 10 AM in the morning. This provides them necessary power to run all the home appliances including lights, fan, T.V and grinder. Out of the 10 households except one all of them solely rely on the micro hydel plant. In the words of Nagesh Bhatt "The state electricity

line doesn't ensure any reliability in the timings of power supply, so we don't want to stop this project which ensures us electricity whenever we need it the most. During heavy rainfall and windy seasons the state board line fails often and the repair is always delayed due to the remoteness of the area". It is also important to note that they have laid underground cables for around 2 kms to transmit the power.

3. Uppukaramedu, Chennai

Uppukaramedu near Ambattur in Chennai has a substantial population of displaced people living near the railway land. Due to lack of proper documents and ownership of land they were not able to avail electricity connections and were completely dependent on kerosene for lighting purposes. The freemason lodge's[21] Jyotir gamaya project aimed at helping them with the provision of household lighting and mobile charging. This intervention was indeed a big step in the penetration of renewable energy as it was surprising that people living within the city limits of Chennai were devoid of electricity.

The Jyotir gamaya project consisted of 800wp solar panels providing a single light point (with a LED bulb) and a provision for mobile charging for almost 46 households. It also provided them with three street lights which is crucial for their mobility and safety. The system was installed by Solarsis in February 2012 where the entire project cost was borne by the freemasonic society so that the community doesn't have any stake in the project. A person from the same locality was selected as the operator and according to people; within the community itself they collected 200 R.s / HH (not related to the Jyotir gamaya scheme). They alleged that now there is no idea of the current status of the corpus amount collected in the beginning.

The project worked well for the initial few months and then the supply hours decreased to almost 2 hours a day (6pm-8pm). Now the project has come to a halt for the last two months and people have switched back to kerosene for which they have to spend a substantial amount of their income for both cooking and lighting purposes. They don't have money to carry out the maintenance of the system and rectify the issues regarding the battery. Routine checks and rectifying issues in the beginning itself could have avoided the shutdown of the project. Close examination of the project reveals that a project like this one could have actually increased the visibility and acceptance of renewable energy projects but in reality it proved out to be a failure due to lack of vision regarding the long term sustainability of the project.

4. Ayyanadaipu, Tamil Nadu

Situated in the coastal belt of Tamil Nadu, Ayyanadaipu panchayath is a small village

[21] An international fraternal organization

on the outskirts of Tuticorin town. The not so remote village has proper grid connected supply and transport facilities due to its close proximity with the national highway. The village was selected for a demonstration project (overall 3 villages in Tamilnadu) of TEDA[22] in association with Minda Technologies by installing a solar micro grid of 240 WP in 2012 for basic household lighting purpose. The main objective of the pilot project was to demonstrate the use of renewable energy technologies as an alternative to the rising power shortages in tamilnadu and thereby familiarizing people with clean energy technologies.

The area of operation comprises of 35 households belonging to the BPL families and the area is characterized by low voltages and frequent power failures (6-7 hours a day). The entire cost of 1.5 lakhs was funded by government of tamilnadu through TEDA in order to complete the project. The project consists of two light points (2x1.5wLED) and provision for mobile charging provided free of cost to the household. Half of the households here are connected to the state grid that they use this as a substitute lighting measure and normally during the time of power failures.

The panels are placed on the panchayath office and the power is distributed through dedicated lines to these households. The project is designed in a way that it is operated automatically from 7pm- 11pm in the night and from 4 am – 6 am in the morning. Upon observations and surveys conducted in the village it was found out that people was finding it a good alternative as many a times there region is facing power failures and this prompts them to use candles and kerosene lamps. In this context it is to be noted that solar has received an increased acceptance among communities as an alternative strategy for energy security. But after a close scrutiny of the project and a FGD with the women certain issues regarding the project were observed.

In many households, (nearly 40%) one of the lamps stopped working and at least in 8 households the entire system was not working owing to the issue of the electrical lines. Within the other households people claimed that they were getting decent supply of light enough to carry out their household activities. Among the HH's which were completely dependent on kerosene and candles these bulbs have actually made a difference by giving them access to clean energy and empowering them with the provision of lighting.

The inhabitants of these areas are mainly working as daily wage labourers due to which there are no basic livelihood activities which are directly impacted by the project. But the project had increased the safety of women and children these areas as street lights are also being lit by the solar project. Education of children has been one of the major areas which have been impacted by the project in a very huge manner. But again there are difficulties in actually quantifying and assessing this due to the difference in perception among people in connection with the quality of lighting. Within the same street there was an experience of 4 children happily studying under the lamp and another person demonstrating the inability to read under the light provided. The lack of clear quantifiable outcome of the quality of these outcomes was one of the major hurdles in terms of assessing the extent of empowerment through these projects.

[22] Tamil Nadu Energy Development Authority

Certain issues which are inherent in freely provided pilot projects were evident in this project also. The lack of maintenance was one of the important factors which were observed in the field. Moreover people and the panchayath officials don't have a clue about whom to approach in case of maintenance. Being a project which is given free of cost there is a lack of accountability which can give a bad impression about renewable energy projects as a whole which is not at all related to technical or economic reasons. This has been a trend in many of such projects wherever the provision of free services in the beginning without a proper ownership by the users would lead to the failure of such projects which are then attributed as the failure of the technology which is not true.

5. Shikegere, Karnataka

On the way to the tribal hamlets in the thick forests of Shigekeri- a village almost 120 kms from Hubli in Karnataka, N.S Bhatt- a teacher of Shigekeri primary school was explaining to me the hardships faced by tribals living in the vicinity of these forests. The lack of roads and the constant human - animal conflicts aggravate the hardships faced by these people who are dependent on subsistence farming. But these thatch roofed huts can boast of the luxury of owning efficient solar lighting systems which provides them with energy access in a place where the electricity grid arrival seems like a distant dream.

'Jyotir gamaya', a solar lighting project for poor families initiated by freemasons lodge international has been providing light to unelectrified poor households throughout the country. It intends to provide solar lighting systems to both rural and urban households with two light points and a provision for mobile charging. Both mini grids and separate home lighting systems are a part of the entire project, where the type of system (mini grid /home lighting systems) is designed according to the terrain and the number of households.

The Shegikere project under the free masons lodge, Dharwad is located in yellapura taluk. The remote location of the village and the lack of proper transport is a major issue in accessing these areas and pose a big challenge to grid extension. The various tribal hamlets are located deep inside the forests and are situated in a shattered fashion that even the idea of mini grids is not feasible in these areas. Moreover the typical need assessment in the households reveals that the major household requirement is confined to lighting purposes. The entire system has been designed in accordance with this and was inspired by the example set by N.S Bhatt who has been living completely off the grid using solar power. Mr Bhatt has been using solar power for more than a decade and was successful in setting an example for the entire village concerning the efficiency and sustainability of the project. Being a teacher in the same village made the coordination of the project through him easy and successful for the organization.

The system consists of a 10 w solar panel for each household and 2 led lights with a provision for mobile charging/transistor. They get bright lighting from 6 pm to 11 pm and for few hours in the early morning also. In addition to this each household has received a solar lantern as a part of government scheme. The lights have been provided for almost 40 households in this area. All of them were previously dependent on kerosene and unlike urban areas they were finding it difficult to obtain enough kerosene for their use as the PDS shops were really far from their villages. The cost of kerosene also turns out to be a burden for them which exacerbate the issue of poverty.

Govindappa, a beneficiary of the project was all praise for the project when he pointed out that "it would be desirable if government could come up with such projects where there are no issues of power failures and major repairs. Previously forest clearance was a big issue for us to get connected to the grid which is completely solved by this project". People have welcomed clean energy technologies in their lives as they find that the practical difficulties in the grid extension would force them to stay in the dark.

Such lighting systems need very little maintenance and can last up to 10-15 years without interruptions, however replacement of the bulbs have been an issues owing to the non-availability of good quality of LED bulbs" N.S Bhatt, who is also acting as the voluntary coordinator for the project was describing the issues of a follow-up. The idea of faster solar energy deployment also means that there should be an increased availability of energy efficient lights at affordable rates for the poor. It is indeed a laudable step that a number of solar kiosks (where there is availability of energy efficient lights and panels) have been planned for rural areas. Such kiosks should be placed strategically that people have access to them without much difficulty. Government can take initiative of this step using the state nodal agencies for renewable energy or by using government mechanism such as post offices or PDS shops.

The project has indeed left a positive impression about renewable energy on people living in these areas. The lack of village electricity committees or any participatory mechanism seems no hurdle when it comes to the sustainability of the project here. As a rule throughout the projects I visited, the only important factor which affected the life of the projects was quick maintenance and follow up of a particular issue. In such a case Participatory electricity committees would be a good platform for grievance redressal but not the most desirable one.

In Shigekeri the primary school teacher who is not from the community has volunteered himself for coordinating this project on behalf of the villagers. The children coming to school can actually communicate the issues regarding the project to the teacher, who eventually contacts the implementing agency for the necessary action to be taken. The policy should mandate the proper coordinating mechanism which is most appropriate for the situation. The transformation of schools, PDS shops, Health centres in rural areas for a hub of such activities would promote the decentralized governance systems and enhance the penetration of government schemes into remote locations.

6. Chief Minister's Solar Powered Green House Scheme, Thoothukudi

The chief minister's solar powered greenhouse scheme in Tamil Nadu is a pioneer in this regard which integrates the scheme of housing for BPL families with solar home lighting facilities. The project which started in the year 2011 plans to build 60,000 houses each year till 2016. The state has allotted a budget R.s 1080 crores for this project every year. BPL families who own land in their name with a proper patta (documents) are identified and considered under various criteria to provide a house of 300 square feet area with a unit cost of R.s 1, 80000 with a split up of 1, 50000 for construction and 30,000 for solar lighting system. This is first of its kind government housing scheme in the country which has a dedicated solar lighting programme integrated into it.

The programme is carried out under the aegis of rural development and panchayath Raj department, Govt of Tamilnadu and the entire solar lighting component is managed by TEDA. It consists of 5 CFL lamps and the solar panel with batteries with a 5 year comprehensive maintenance contract by the developer. The houses are provided with grid backup and when the net metering policy of government comes into action they can sell excess power back to the grid which is believed to be an important step in promoting the scheme. The guidelines of the project have emphasized three important factors which are crucial to the sustainability of the project.

- TEDA shall bring out Brochures/Hand outs and other training materials on the usage and maintenance of the SPV equipments. A Hand out on Dos and Don'ts should also be prepared by TEDA in the local language and distributed to the beneficiaries.
- Training Modules shall be prepared by TEDA to train the Panchayath Presidents, Panchayath Secretaries, select SHG Members and other local functionaries deemed fit, so that they can serve as effective interface between the beneficiaries and suppliers. the commissioning agencies shall be responsible to train the beneficiaries as well as 4 SHG members in each Panchayath to do regular maintenance
- A call centre would be opened to deal with the queries and complaints of the beneficiaries.

These suggestions prove to be an important aspect which can ensure the smooth functioning of the project. Many a time lack of emphasis on such a provision in renewable energy projects has led to the complete failure of the project. The provisions for the increased presence of panchayath and SHG's are expected to ensure that the decentralized approach is followed in the case of proper maintenance of the project. This in turn would increase the scope of availability of 'green jobs' by engaging the local population with in the loop of maintenance and follow-up. In our country panchayath officials and ward members do play an important role when it comes to the dissemination of the benefits of various schemes to the end users. The provisions for hand-outs and call centre facilities would enable people to tackle the issue of

information asymmetry and is expected to equip themselves with quicker service at their doorsteps.

As a part of the site visit, 3 households were interviewed in Ayyanadaipu panchayath who were the beneficiaries of the scheme. With decent infrastructure and perfectly running solar lights the beneficiaries were quite satisfied with the project with almost nearing a year after completion. “The addition of solar component is very useful for us when it comes to household lighting. From 6 – 10 pm we are getting bright light and this helps us to save money in the electricity bill”.Ganeshan, one of the beneficiaries was appreciating the project. Even though the project is fully funded by the state government, the beneficiaries are required to provide their labour towards the civil works for the construction and the amount is released in instalment in accordance with the completion of each phase. This ensures that the money is not diverted and the ‘sweat equity’ provided by the beneficiary is useful in ensuring the sustainability of the project. The fact that there was a follow up maintenance check by a technician to these areas is also a welcome step in this regard.

7. Agumbe Rainforest Research Station, Karnataka

ARRS is that the station is running completely off grid using solar. They use an array of 12 panels (BHEL L1270 type) which together produces a total of 890 WP which is enough to run the entire station. The station also had a microhydel unit which is not functioning now. Even though agumbe has heavy rainfall throughout the year and a steady availability of water the microhydel project is not working properly due to lack of proper maintenance. On the other hand the solar panels are working properly and the battery had to be changed once due to technical issues. As the routine maintenance is carried out properly the solar power system is continuing its operation ever since its installation in 2005.

On comparing the micro hydel and solar projects within the same campus the importance of the flexibility in use of renewable resources, the need of routine checks and proper maintenance of particular technologies is highlighted. On one hand we have a micro hydel project in Sirimane which has been empowering communities for almost 10 years with an uninterrupted supply of power and almost in a similar setting the micro hydel project seems to be a failure but the solar panels are working properly.

The availability of locally trained technicians and operators becomes an important factor in the case of projects like micro hydel which has mechanical parts and rotor systems which needs

thorough checks and inspections. In the case of such remote locations where technicians are not readily available solar is quite flexible and for small institutions this becomes affordable and adequate for their needs.

8. Gram Oorja, Darewadi

A recent visit to Darewadi solar project, a village situated 140 km away from Pune (9.4 Kw Solar PV) by Gram Oorja is worth mentioning at this point when we critically think about developing various aspects of a proper mini grid framework. The 40 households in this small hamlet were completely dependent on kerosene till the execution of the project in 2012. The Project is one of the most efficient Mini grids I have ever visited throughout the country with its quality components and individual metering systems for each Household. In sizing the equipment the growing aspirations of people (anticipating the addition of new equipments in future) have been taken into Consideration unlike most of the undersized *'only for lighting'* projects in the country. This is indeed a welcome step when we talk about decentralized systems moving from a *stop gap* measure to the *long term solution* for energy access.

A village electricity committee is managing the tariff collection, decision making and acts as a regulatory mechanism within the village. Every month the collected amount is remitted in the nearby bank even though the collection efficiency is average. This is to be used for the replacement of the battery and other maintenance charges. In a way previous experiences shows that imparting the sense of ownership with proper tariff collection has long lasting impact on the sustainability of the projects. Many free projects in the past have failed due to the issues with battery and maintenance and the lack of corpus amount for maintenance. In the case of productive loads two pumps and an Atta chakki is being put to use with the electricity from the project. The maintenance of the system is also carried out properly with a person form the company visiting the site at least once in a month or in case of emergency repair. But during monsoons power failures and low power production used to be a major constraint.

9. Rawan and Mohda, Chattisgarh

The success story of CREDA in imparting electricity access to nearly 1500 remote villages was the background picture for the field visits to Rawan and Mohda villages near Bhawanpara wild life sanctuary in Chattisgarh. The field visit was carried out as a part of the Conference on Mini Grids

conducted by Centre for Science and Environment, Delhi. The 2 hour drive from Raipur was filled with discussions regarding the sustainability of the model where CREDA claimed to charge only 5 R.s 5/HH/month for the connection which consisted of two light points and to charge a mobile in a HH and 14 street lights for the village. The model which gets 50% MNRE subsidy and the rest being financed by the state (by collecting a CESS of 5p/unit/connection from the conventional consumers as Urja Vikas Nidhi) is used for this purpose.

The claim was that people are being supplied electricity for 6 hrs a day with an efficient support structure consisting of village level operator, cluster level technician for routine maintenance and repair.

From the interactions with the villagers it was found out that the power was available only for 2 hrs a day with some days without complete electricity. Rawan village with a 7 kW system (3 kW added afterwards) was initially designed for only 72 connections with the assigned loads for lights, mobile charging and street lighting. According to the CREDA field staff the number of connections has almost doubled with an increasing number of televisions added to the issue of low duration of power supply. It is also to be mentioned that the school didn't have a connection for operating computers. There were also no productive loads so to speak. In the nearby village Mohda the situation was similar with the exception that the entire village was going to be resettled to a new area owing to the human animal conflicts due to the close proximity of the village to the forest**.**

10. Kalahandi, Orissa

In Kalahandi district Orissa, two type of projects were taken into consideration for the study

1. Solar Home lighting systems – Along with Prayas study in Nakrundi Panchayath HH surveys were conducted in order to find out the effectiveness of SHL's programme implemented by District Rural Development Agency with Orissa Renewable Development Agency under the Remote Village Electrification Programme. They were provided with solar panels with single bulb and switch point. The project was completed in 2010 and in a condition was the RGGVY grid line is unreliable; solar has been the only reliable option for the people. A committee was formed in each village with a monthly collection fee of R.s 30/HH to be deposited in the bank account. But in 90% of the villages the collection stopped after the first three months which has resulted in a lack of corpus fund for replacing the batteries.

In most of the places, people have now started filling distilled water in the batteries and are regularly cleaning the panels. The provision of this basic lighting has been proved as a boon for the women as they can cook their food easily even in the late hours for night. This has increased their mobility and also the youth and children can read in the night. But the maintenance mechanism is extremely poor that none of the technicians have visited these

remote villages after the installation. Lack of proper community mobilization has left out a situation where in two three years when the battery is damaged the people won't be able to replace them.

There is also an issue of lack of availability of the CFL lamps for replacement, once they are damaged. More over in some places people have started using T.V sets and CD players which denote that in a long run the existing capacity of the systems won't be supporting the growing aspirations of people. Proper care has to be given in addressing the issue of maintenance otherwise people will lose faith in the solar system which now acts as their only resort in a scenario of poor grid facilities.

2. Community Micro Hydro

Mainly four sites were visited in the district of Kalahandi that were community initiatives-owned and operated by them with the help of an NGO, Gram Vikas. The sites are Purna Guma, Punjam, Amthagouda and Karlapat where in all these places meetings of Village Electricity Committees were attended and were closely observed. Two of these were still working properly whereas the others were shut down due to maintenance issues.

The mechanism of village electricity committee was indeed interesting with people coming together to discuss about various issues regarding the micro hydel plant. Even though there were caste and class issues playing out in these meetings a great deal of decisions were taken in a democratic manner with great amount of deliberations and discussions. Some of these plants were located in areas where the RGGVY line has reached. There were uncertainties regarding grid interconnectivity and the future of the micro hydel plant. But people wanted to continue the project after raising enough corpus amounts as the grid was unreliable.

11. Ottainatham, Tamil Nadu

A 3.5 Kw waste to electricity system was visited in Ottainatham panchayath in Tamil Nadu where the waste from the latrines in a park is converted to biogas. Then the biogas is used to run a generator and provide electricity for lighting the park and the streetlights around the village. This is in its initial pilot stage mainly used as a demonstration project by Tamil Nadu Energy Development Authority. Such projects are indeed the way to go in future where local self-government entities also play an important role in the planning and execution energy projects. The women's Self Help Groups play a proactive role in maintaining and operating the project in a proper manner. They were given training in this regard and such a model can be replicated in other villages with a dedicated programme in place.

Annexe 2: Questionnaire

Sl no	Lighting (House Hold)	Respondent category
	No of light points available?	Adult
	Type of lights used (CFL/LED)	-do-
	No of hours of availability of bright light?	
	What was the previous source of lighting?	-do-
	If kerosene the average monthly consumption amount	-do-
	Health issues due to the usage of kerosene	-do-
	Reduction if any in the usage of kerosene post project	-do-
	Present quantity of kerosene consumed per month	
	Amount spent on kerosene (break up of both from PDS entitlement and outside)	

Sl. No	Electrical appliances (HH)	
	Details and wattage of other appliances in the HH	
	Whether mobile charging can be done using the electricity available?	
	Is there a provision for mobile charging (in the case of SHS system)?	
	Whether mobile communication has influenced their earning patterns? (specifics) (a) Better access to information regarding Govt schemes (krishi vigyan) (b) Better connectivity with the village officials in compliant redressal	
	Types of programmes which are popular in T.V (News, entertainment etc.)	
	If the supply would have increased whether they could afford to buy a T.V Any other appliance (affordable) which they would like to buy in the short term if there is an increased reliability of supply. How they get finance to buy the appliances (MFI, money lenders etc.) How useful is radio and television in their view for having a useful impact in their lives?(to take their views rather than assuming it will have such and such impact in their lives)	

Sl No.	Reliability (HH and Developer)	

	Hours of operation of the project (to verify the difference between promised and actual)	
	Frequency of power failures , outages and voltage fluctuations	
	Whether power is available at peak hours of demand?	
	Frequent shutdowns for maintenance?	

Sl No.	Gender equity (questions to women)	
	How the workload of women has decreased with the advent of electricity?	
	Whether they could indulge in entertainment activities? (access to television)	
	Whether there has been increased information regarding health and sanitation?	
	Number of women members in the VEC's	
	No of Women entrepreneurs using the benefits of electricity supply	
	Whether the mobility and safety has increased in the night time?	

Sl No.	Tariffs and affordability (HH)	
	Present tariff paid by the consumer	
	Whether there is any fixed amount for the initial connection? If yes ,the amount	
	Is it a fixed or 'pay as you use' system?	
	Whether the tariff is affordable?	
	Whether the spending has been decreased compared to kerosene?	
	Whether there are proper bills/receipts are received while payment?	
	If yes, have you ever cross checked the amount and particulars written on it?	
	Do you think that the tariff is high?	
	Any information about the tariffs paid by nearby villagers for electricity?(both grid connected and off grid)	
	How do you manage to pay the tariffs (from monthly savings, daily collection or even borrowings from others)	
	Are there any defaults in payment?	
	If yes were you penalized for that? (Removal of connection, fine etc.)	