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Review of Alternative Participatory Business Models for Off-grid Electricity Services

By P R Krithika and Debajit Palit
TERI, New Delhi

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1. Introduction

Bringing modern electricity services to more than 400 million South Asians who do not have access to grid electricity will require a variety of innovative mechanisms. Most off-grid populations lack not only the ability to easily pay for electricity, but also the active demand for electricity necessary to support financially viable energy programs. Innovative strategies for rural electrification are crucial to success – whether through innovative financing programs, marketing strategies, or distribution channels.

Since off-grid electricity implementation is *ipse facto* decentralized, many have been able to experiment with different business models for implementation. Implementation models are driven from different sources – from regional governments looking to increase economic activity, from communities looking for access to energy, as well as from private entrepreneurs looking to build for-profit energy businesses. These models of course have different strengths. Community-driven models will often provide superior local support. Government models typically reach a broader range of consumers. For-profit ventures often focus more heavily on financial viability. On a smaller end, some have focused on implementing end-consumer products – selling individual lanterns, solar home systems, or other products. Others have focused on installing mini-electricity grids, using a village-scale power plant. This report examines various business models in the rural electrification sector with a focus on off-grid models using clean sources of energy. As providing grid connection is by far the main model for electrification in South Asia (refer "Off-grid electrification experience in South Asia: Status and best practices" by TERI), this report explores certain business models for grid extension for rural electrification also, in addition to the off-grid electrification efforts. Given the vastness of the literature available on various electrification models adopted across the world, the review will necessarily be a partial one but attempt has been made to capture the models prevalent in the south Asian region and their essential points.

While examining various business models, it is also important to draw a distinction between business models and participatory models. A business model for an off grid electrification project is basically an overall framework within which the project operates including the choice of technology, financial viability of the model, institutional set up, role of various stakeholders and the regulatory & policy framework. In a business model, the underlying motive for an investor is profit which assumes central importance, however in a participatory model the underlying objective is to create access to electricity through sustainable partnerships with the local communities. Participation of the communities is the centrepiece in a participatory model. This report has attempted to cover business models including participatory ones, so that lessons from both can be drawn to develop the framework for the current research.

Further, a number of previous studies have developed their own classifications for electrification models. After reviewing those classification systems, this paper proposes its own system, synthesizing the prior models. A review of literature shows that while there is no formal definition for business models in the off-grid sector, there are a number of perspectives which broadly converge on the same idea. The World Bank defines various

electricity supply models based on the form of ownership (State owned, NGO, private sector) and type of technology (Grid extension, off-grid) (ESMAP, 2006). Appendix 1 provides the matrix of electricity supply models developed by World Bank.

Specifically for solar home system dissemination, the World Bank has defined four different institutional models (Cabraal, 1996): cash sales, consumer financing through dealers and commercial banks, leasing arrangements, and fee-for-service. Each of these institutional models has specific characteristics with respect to ownership, financing mechanisms, flows of products, services and money. At the same time, UNDP defines four basic delivery models particularly for solar PV systems (UNDP, 2004). These are summarized as follows:

(i) *Commercially led models* which are driven by suppliers and dealers with relatively little government control. The model typically operates on the basis of cash sales and relies upon merchants that may be dealing in many other commodities. The consumer is responsible for long term maintenance or the dealer provides maintenance on a cash recovery basis.

(ii) *Multi-stakeholder programmatic model* wherein a project management unit or multi stakeholder management authority is typically charged with reaching rural consumers. Consumer credit is usually offered through an intermediary finance organization which is sometimes a village level cooperative or an informal bank.

(iii) *Utility model* typically operates on a fee-for-service basis. In these cases, the utility or a rural energy service company seeks to establish a long term relationship with the rural consumers but retains ownership and maintenance responsibilities for the systems installed. The consumer pays on a monthly fee but the utility of the ESCO must carry the debt service associated with the capital cost of the PV systems.

(iv) *Grant based models,* which typically apply to institutions - schools, clinics and missions. Bulk procurement typically occurs at a national level and the systems are then delivered and installed locally, leaving the operation and maintenance to local hands.

Drawing from these classification systems, we identify five models of different types of operation that have been used in rural electrification.

1. Electric co-operatives;
2. Distribution franchises;
3. ESCO/Fee-for-service models;
4. Community-managed operations; and
5. Private sector models.

Figure 1 gives an overview of various business models in electrification attempted in this paper.

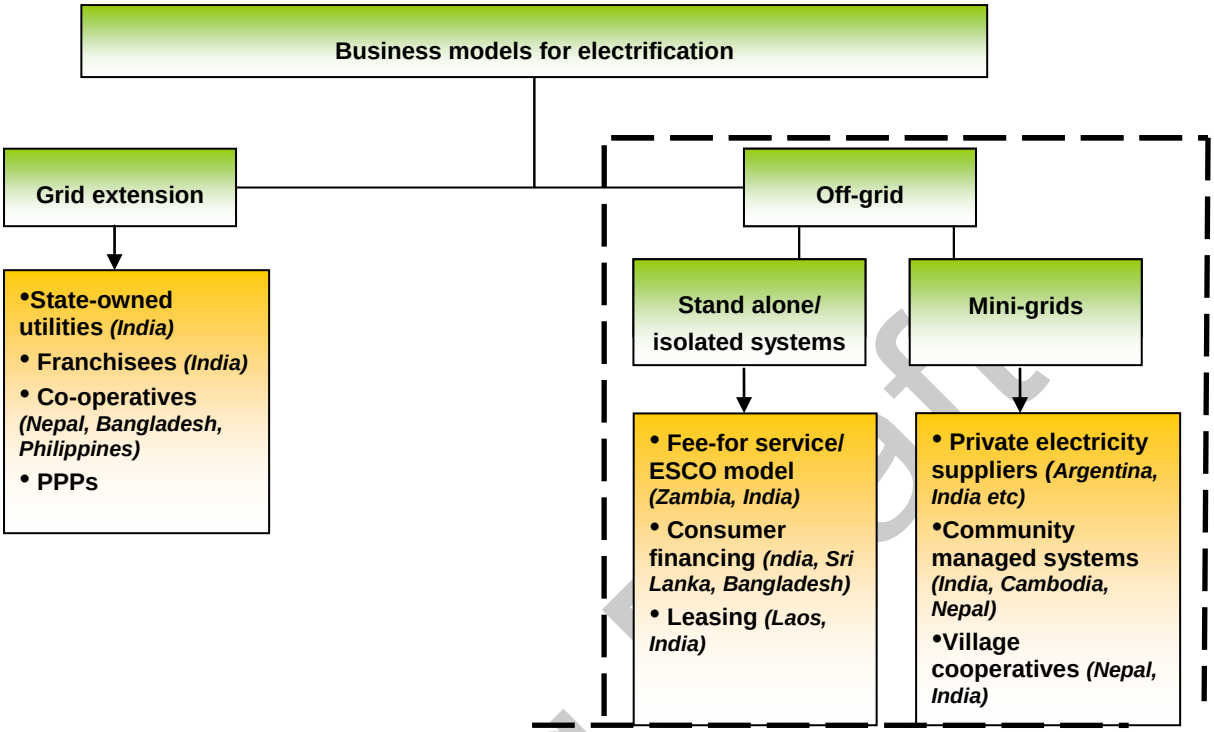

Figure 1.1 Business models for electrification

Source: TERI

By reviewing alternative business models especially the participatory ones, in off grid electrification in South, South East Asia and Sub Saharan Africa, this paper look to identify key factors that have contributed to failures and successes of these models. While a number of different models have been implemented in the off-grid electrification system, some models have had better results than others. This report looks

- to understand how different organizations have modelled their off-grid and rural electrification supply programs,
- what those models look like, and
- what has been successful and challenging about each model.

We explore the challenges and strengths that have arisen from recent implementation using these models. At the end, this paper also shares the key points to consider for an appropriate business model, which could provide the inputs for the designing the framework for future off-grid implementation efforts.

2. Electric cooperatives

A cooperative is a business organisation owned and operated by its members for their mutual benefit (Tchami, 2007). Rural electric cooperatives works on the same principle and are democratically governed businesses, motivated by socially orientated goals of local development. Cooperatives offer an attractive alternative to public sector management or principally profit-motivated private sector involvement. As cooperatives function on a one member one vote basis, they promote equal participation and empower rural people to shape the course of local development (Cruickshank and Yadoo, 2010).

This model has been experimented widely across the world starting with USA in the 1930's to developing countries such as India, Bangladesh, Nepal, Philippines etc. Box 1 provides the basic principles underlying the functioning of cooperatives.

Box 1

Cooperative Principles

Voluntary and Open Membership
Cooperatives are voluntary organizations, open to all persons able to use their services and willing to accept the responsibilities of membership.

Democratic Member Control
Cooperatives are democratic organizations controlled by their members, who actively participate in setting policies and making decisions.

Members' Economic Participation
Members contribute equitably to, and democratically control, the capital of their cooperative.

Autonomy and Independence
Cooperatives are autonomous, self-help organizations controlled by their members.

Education, Training, and Information
Cooperatives provide education and training for their members, elected representatives, managers, and employees so they can contribute effectively to the development of their cooperatives.

Cooperation among Cooperatives
Cooperatives serve their members most effectively and strengthen the cooperative movement by working together.

Concern for Community
While focusing on member needs, cooperatives work for the sustainable development of their communities.

Source: http://www.nreca.org/AboutUs/Co-op101.htm

2.1 Rural electric cooperatives in Bangladesh

The Rural Electrification Board (REB) in Bangladesh established in 1976 has been successful in extending electricity access to rural areas in Bangladesh by forming electric cooperatives known as "Palli Bidyut Samities" (PBSs). The REB has divested the distribution of power to end-users through PBSs to ensure local ownership and participation. Each PBS is responsible for providing grid extension to approx. 5-6 districts. At present there are 70 PBSs operating in Bangladesh providing approximately 81, 20,611connections (as on October 2010). Though PBSs are independently and privately owned, yet they remain under the direct regulatory control of the REB, which manages the procurement process, financial sustainability and management effectiveness (Cruickshank and Yadoo, 2010). The REB controls the PBSs in their infancy stage and later envisages providing financial and operational autonomy once the PBSs become profitable and self sufficient (Rejikumar, 2007).

Each customer is a member of the PBS, which prepares a master plan for the electrification of its operational area based on forecasts of load growth of the area it covers. The responsibility of managing a PBS's financial and operational activities is entrusted with the member-consumers in accordance with set rules of the PBS. The member consumers participate in the decision making through elected representatives to the PBS governing body. The PBS has a board of directors consisting of 12-15 members who are elected on an annual basis to manage the business and affairs of each Samity. While the tariff setting authority vests with the PBSs, it is still subject to the approval of REB. Cross subsidies are permitted, however average tariffs are set so as to cover for operation, maintenance, depreciation and financing costs. REB also prescribes the by-laws for the PBS as well as operational, technical and administrative standards of rural electrification.[1]

Additionally, REB assists the PBS in planning and designing of the distribution network; conducting initial organizational activities relating to institutional development; constructing substation and electric lines; providing training to PBS personnel; and monitoring management, financial, and system operational activities. REB also offers the PBSs subsidized financing through low interest loans with long repayment periods. During the start up period (upto 6 years) cooperatives with losses receive direct subsidies and a common revolving fund allows them to benefit from cross subsidies.

There is a strict system of "checks and balances" as far as the procurement procedure is concerned and the REB instils a strict discipline into the process through comprehensive training in the areas of management, rules and regulations (Rejikumar, 2007). The REB also hires the executive management of the PBS and has the power to terminate their employment with the PBS board approval for non-performance. The most important feature of the model is the annual performance target agreement which the PBSs have to sign with REB, covering 22 parameters broadly committing to increase revenues and connections, decrease losses and improve service quality, based on previous year's achievements. PBSs that attain the set targets are rewarded with incentive bonus upto 15% of the salary, on the other hand, PBSs which fail, have to face financial penalty.

The PBSs have been touted to be a successful model as they have been able to achieve 15.5% distribution losses as compared to the national average of 30-35% losses, 97% collection efficiency which is far higher than that of other utilities. So far, they have been successful in providing electricity supply to 47641 villages in Bangladesh.

[1]As per Bye-Laws, the PBS shall at all times be operated on No Loss-No Profit basis for the mutual benefit of all its Members and non-members alike and is expected to repay all indebtedness on schedule.

The PBSs which are essentially centralized grid connected systems are now focussing on off-grid technologies also. The renewable policy of REB has selected solar home systems as the preferred option for providing electricity to those regions of Bangladesh that will not be reached atleast for next five years. The arrangement is by "Pay for Service" where the equipment is owned by the PBSs and the consumers pay fixed monthly bills for 20 years according to their chosen system configuration. PBS is also responsible for the maintenance of the systems.

2.2 Cooperatives in Nepal [2]

Community based organizations (CBOs) in Nepal have been involved in the grid extension projects, falling under the purview of NACEUN (National Association of Community Electricity Users-Nepal)[3]. NACEUN has 207 CBOs spread across in 47 districts. Till date around 1, 11, 344 rural households have been electrified[4]. The cooperative's board is made up of four voluntary members who manage the daily operations. An annual meeting is held for all the members of the cooperative and the shareholders to approve the action plan, policies and budget, while the executive committee (board members plus nine other members) meets on a monthly basis.

NACEUN's first point of contact with CBOs occurs after the proposal for grid extension has been submitted to it. Following the payment of a membership fee (US $20/year) the CBO is incorporated into the NACEUN network and can benefit from a wide range of training on subjects such as in-house wiring, electrical safety and productive end uses. The CBOs charge households an initial connection fee (approximately US$ 67 with all in-house wiring, cost of the meter and basic wiring included) and then provide electricity at the tariff rates specified by the NEA for rural areas. The revenue generated from tariffs goes towards the operation and maintenance costs of the cooperative. The CBOs are free to choose to subsidize the tariff to their poorest members if desired. Many of the CBOs have formally registered as cooperatives and offer micro-financing loans to their members to promote productive end uses of electricity and other income-generating activities (such as poultry raising, carpentry, computer work- shops, etc.). Others are also looking into investing some of their profits into off-grid or near-to-grid systems to further extend electricity provision into nearby areas.

A case in point is the South Lalitpur Rural Electric Cooperative (SLREC) which has set up a revolving fund to provide micro- loans to its members from the seed capital donated by donors and personal contributions from shareholders. A social mobilizer is employed by the cooperative to work with households and communities interested in receiving loans. Poor households unable to connect to the grid without initial financial assistance are prioritized for receipt of loans, followed by local income-generating activities, productive end uses and welfare projects such as biogas digesters. Loans vary from an average of US$ 60 (plus 10% interest) for a new connection to an average of US$ 268 (plus 14% interest) for a small enterprise and typically require repayment within 12–18 months. From the beginning of the scheme in July 2005 until the end of July 2008, these micro-loans were directly responsible for 167 new meter connections, 237 new small enterprises (loans funded carpentry tools, poultry farming, mills, irrigation units, grass cutters and a community milk refrigeration unit) and the building of 23 biogas digesters. Though there are bottlenecks which the cooperative

[2] Cruickshank and Yadoo, 2010

3 NACEUN's responsibilities include 1) national level policy advocacy, (2) capacity-building, technical training, administrative and management support for its member organizations, (3) institutional development, and (4) research and promotion of some renewable technologies (for example, biogas and improved cooking stoves

[4] http://naceun.org.np/about-us/what-we-are-doing.html, accessed on 20th Dec 2010

faces in terms of timely repayments of loans from households and it has been seen that about 30% of the loans are paid late.

Another problem faced by the CBOs is their ability to retain personnel once trained by the NACEUN as technicians or linesmen. It has been observed that approximately 7% of technicians trained by NACEUN have migrated to cities in search of better jobs. To avoid this problem, the NACEUN has now set criteria for selection of technicians to be trained.

Inspite of these minor hurdles and bottlenecks, one can broadly conclude that the CBO-led approach to decentralized electricity distribution and management has been successful. The following improvements have been witnessed in cooperative driven service delivery:

1. There has been a reduction in tariffs paid by the communities after they were serviced by the cooperatives as the communities used to pay US$ 455/month receive electricity from a diesel generator but now they pay only pay their local cooperative US$ 94/month for the energy they use from the national grid (generated from hydropower).
2. System losses have declined from around 25% under NEA management to around 15% within one year of community management (mainly achieved through theft reduction).
3. Unpaid bills from as long as five years were settled once the community took over management and the NEA was paid for the electricity promptly each month based on the bulk sales meter readings
4. The CBOs' costs for meter reading and system maintenance are also lower than under the NEA since the linesmen live locally and can respond immediately to service disruptions. On average, the time required to acquire a household meter was reduced to one day and the time for a three-phase meter for pumps and industries was also substantially reduced.
5. Productive end uses training has helped in increasing the rural communities income. The heightened sense of awareness stemming from regular training provided by the cooperatives has empowered the local communities by enabling them to realize that they can hold the management accountable and thus led to improvement in service.

2.3 Rural electric cooperatives in India

While most of the literature on India's electricity cooperatives is dated, an attempt has been made to assess the strengths and weaknesses of this model based on the available literature. Indian experience with the cooperative model has not been very encouraging. India experimented with the cooperative model in 1960's with assistance from NRECA and USAID. Forty one cooperatives were formed of which 14 are in operation, while 22 cooperatives have been taken over/ liquidated by the respective state utilities/governments. The electricity cooperatives are registered under the State Cooperative Societies Act and they are mostly funded by the apex body for rural electrification viz. Rural Electrification Corporation. Electricity is sold at bulk rates to the cooperatives by the SEBs/ distribution utilities. The electricity tariffs are set by the state electricity regulatory commissions. Of the operating cooperatives, those that were established with NRECA's assistance in Maharashtra, Karnataka, Andhra Pradesh and Uttar Pradesh have survived and in general have fared better than the cooperatives set up by the states (NRECA, 2002). India's experience with electric cooperatives has been seen both in grid extension projects (as part of RGGVY scheme) as well as in off-grid projects. The case study of two off-grid distributed generation projects managed by cooperative societies in the Sunderbans region, West Bengal are discussed here:

Case Study 1

Electricity Cooperatives in Sunderbans, West Bengal

This case study examines two off-grid distributed generation projects initiated by West Bengal Renewable Energy Development Agency (WBREDA) in the Sunderbans, viz., a 500 kW Biomass Gasifier System at Gosaba Island and a 26 kWp Solar Power Plants at Sagardweep Islands.

Gosaba Rural Electricity Cooperative Society

The Gosaba RESCO is a rural isolated mini grid electricity supply scheme set up with the help of WBREDA. A 500 kW biomass gasifier system was installed in Gosaba island of Sunderbans in July 1997 with the objective of supplying electricity to 10,000 people spanning across 5 villages in the island. The capital cost for the project was Rs 10 million and most of the capital was provided by WBREDA and also undertook the construction of the plant and training of the operators for the biomass gasification plant and the electricity distribution mini grid. The members provided some capital from the society membership fees and some construction labour.

Solar power Cooperatives of Sagardweep Islands

The Sagar Dweep Solar PV Project was initiated keeping twin objectives of providing quality power to rural remote areas and also to showcase the viability of SPV to achieve the former.

Electricity uptake

WBREDA's model of implementation is usually in a local mini grid mode. Both 11 kV and LT grid network is created by WBREDA depending on the capacity of the power plant and evacuation of power from the plant. To maximize the plant load factor, WBREDA established the plant near the load centre and creates a 2-4 km of mini grid in the area for supply. This minimizes the distance to the consumers, thereby, reducing transmission and distribution losses and increases the plant load factor at the same time.

Service delivery model

The service delivery model is same in both the projects; and has been implemented and operated by RESCOs with the support of WBREDA. The co-ops are responsible for the operation and maintenance of the plants, billing, collection, new connections when required and disconnections for failure to pay. The rural banks operating in the area worked as intermediaries between the cooperative and individual consumers to collect bills based on actual consumption. A minimum charge has been set that has to be paid by the consumer irrespective of the consumption levels since the plant load factor has to be maintained for sustained supply. In the case of Sagar Island SPVPP, the cooperative is charging roughly between Rs.2.5-3.75 per unit against the estimated Rs.10-15 per unit for SPV systems. In Gosaba Island, the society charges Rs.3.25 per unit to domestic users and Rs.3.75 per unit to commercial consumers.

Socio-economic benefits

- Development of small, micro and medium enterprises in the region like boat repairing, grill welding, spices grinding Xerox machines etc.
- Education sectors have benefited most from these projects since students can study in night and get good grades in the examinations. Availability of photocopy machines also facilitates copying of books those are other-wise pretty costly and remain unaffordable.
- Benefits in terms of healthcare have also been interpreted from the project. Quantifiably, an operation theatre has been made functional in Gosaba island because of availability of refrigerators (to store indispensable vaccines and medicines)
- Since most of the water in the vicinity is saline in nature, water desalination plants and water extraction pumps are some of the important gifts from the project that could be actualized on the site.

Key lessons

- In both the cases, quality grid power was supplied to the consumers for 6-8 hours rather than only for lighting. This resulted in a tremendous response from the consumers and in turn increased their willingness to pay as well.
- The main reason for success was the tariff that was set according to existing diesel generation tariff as well as was abreast with the willingness to pay estimate of the consumers. The West Bengal Electricity Distribution Company already operates a diesel electricity generation centre in Sunderbans and supplies power at the rate of Rs.4 per unit). While power from these projects was intelligently priced between Rs.2.50-3.75 per unit for solar project and Rs.3.25-3.75 per unit for biomass project, to keep it in the range of existing paying capacity of the consumers.
- Fuel supply remains a major issue for biomass gasifiers, Gosaba Island is no exception. Although a 75 Ha energy plantation has been raised in the vicinity to ensure a consistent supply, a deficit exists in the supply and demand of woody biomass, which sometimes hampers the power generation.
- High capital costs of the plants as well as difficulty of providing power to energy intensive units are some of the downsides of this model.
- Transmission and distribution (T&D) losses are comparatively high (13%) in such a small-decentralized biomass gasifier plant. This is by virtue of the longer low-tension lines to cover a vast expanse throughout the command area.

Source: Iyer and Misri (2007) and TERI (2008)

The fact that very few cooperatives have survived in India is indicative of the failure of the model to take off in a big way. Some of the factors responsible for the poor performance of the cooperatives are as follows:

1. The fundamental cooperative principle is missing as the RECs were constituted in a top-down approach through departmental actions.
2. Cooperatives in India have been subject to political interference. Many powerful politicians interfere in the day-to-day work of the cooperative which has caused some disputes and delays of the power supply activities (NRECA, 2002)
3. The electricity cooperatives were operating in a very restricted environment. In most situations, there were nominated administrators imposed by the government and senior officers of SEBs were often sent on deputation to act as managing directors of cooperatives. (Singha, 2007)
4. The societies are registered under Cooperative Societies Act and are regulated by Registrar of Cooperative Societies. However they are also regulated by the respective SERCs/ministries which issue conflicting directions.

Table 1 summarizes the strengths and weaknesses of the cooperative models in India, Bangladesh and Nepal.

Table *1: Strengths and weaknesses of the electric cooperatives*

	India	**Bangladesh**	**Nepal**
Strengths	• Cooperative's intrinsic requirement to offer universal coverage to its designated area. • Average revenue realization has increased. • Release of new connections, load enhancement etc. is effected within 2-3 days of applying.	• Good performance of the PBSs owing to the incentive-penalty mechanism as part of the Annual Performance Targets agreement. • Significant reduction in electricity theft which can be attributed to peer pressure to control theft. If one member of the group taps electricity illegally all the members must pay for the cost. • Well-defined systems adopted for procurement, tariff setting, meter reading and collection • A fruitful relationship between REB and PBS. • Appropriate organizational procedures.	• Productive end uses training have improved rural incomes. • Lower system maintenance costs. • Financial support extended to poorer households not able to afford electricity connections. • Speedier access to services. • Heightened sense of awareness amongst the members owing to numerous trainings provided by the cooperatives.
Weaknesses	• Top-down approach of management as most of the cooperatives are controlled by the SEBs/ discoms. This leaves them with very little operational autonomy. • Unfavourable load mix forced on the cooperative societies on account of SEBs proximity & influence of State Govt.	• Very limited operational autonomy. • PBSs electrify only those villages which satisfy revenue requirements. This leads to a situation where some communities remain non-electrified for several years until they satisfy potential for productive use of load growth.	• Large cooperatives vulnerable to local political power struggles

	• Management of the societies being registered under the Cooperative Societies Act of the state govts, is highly susceptible to political interference. The regulatory power conferred to the State govt under the Act, is often misused on account of State govt.'s own political priorities.		

Source: TERI Analysis

3. Electricity Distribution Franchisees

Public-private partnerships through electricity distribution franchises, both in urban and rural areas of India, have proven to be extremely successful in improving commercial viability and sustainability. An electricity distribution franchisee is an entity empowered by the discom to either develop/operate a generation and distribution system or ready to distribute electricity within an identified contiguous area for a prescribed duration and collect revenues directly from rural consumers. The franchisee may have the option of generating its own electricity requirement; off-take supplies from the power utility or do both. Franchisee based electricity distribution primarily through grid extension is being successfully implemented in India. This is an integral part of the Government of India's (GoI) rural electrification programme – Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY). The GoI launched the RGGVY in April 2005 with the goal of electrifying all un-electrified villages/ un-electrified hamlets and providing access to electricity to all households in five years. The introduction of franchisees has reportedly led to better metering, billing, and collection practices, higher collection efficiency, and reduced distribution losses.

Broadly there are two types of franchisees operating in India viz. revenue based and input based franchisees.

3.1 Revenue Franchisee

The role of this franchisee is limited to billing, revenue collection, complaint redressal, facilitating release of new service connection and keeping vigil on the status of distribution network in the franchised area for providing appropriate feedback to the utility. There are two types of franchisees under revenue based model – collection and partial input based. The only difference in these models is in the target setting mechanism. For a collection franchisee a target is given for revenue collection every month (which depends on the baseline collections in the area). However, in the input based, the input energy into the area covered by the franchisee is measured by the utility and the targets for revenue collection are set based on the collections made as a percentage of the input energy supplied to the consumers beyond the point of metering by the utility. In cases, the operations and remuneration methodology is identical, which involves:

i) Paying the franchisee margins (which will be a percentage of collections) on achievement of the target

ii) A levy of penalty for not achieving the target

iii) Incentives for exceeding the target.

The biggest drawback in the collection based model is that the Franchisee is not a partner in loss reduction since his remuneration is linked to the collections made and not on the energy input coming into the area. This shortcoming however, is taken care of in the input based model.

3.2 Input Based Franchisee

In this model, the franchisee buys the electricity from the utility and pays the energy charges to the utility at a pre-determined rate. The energy supplied/purchased will be as shown in the feeder/DTR metering unit. The franchisee collects revenues from the consumers

through raising bills so as to have sustainable commercial operation. An extension of this model is an operations and maintenance franchisee where in the franchisee is also responsible for the Operation and Maintenance of the 11 kV and LT feeders including distribution transformers to the Franchisee based on monthly retainer basis or at an adjusted energy purchased price (of the utility), factored appropriately considering O&M cost of the franchisee.

The franchisee model operational in Bhiwandi region in the state of Maharashtra is discussed in Box 2 below:

Box 2
Bhiwandi model

Experience of Bhiwandi model- Input based Franchisee

Bhiwandi city in the Indian state of Maharashtra is a textile hub catering to 1.6 lakhs consumers. The distribution network in Bhiwandi Electricity distribution circle was characterized with high AT&C losses of around 60% in 2006. Revenue collection stagnated at around INR 2400 million between 2001-02 and 2006-07 though sale of power grew from 859 MU to 1225 MU during the same period. In order to reduce the losses, MSEDCL (Maharashtra State Electricity Distribution Company Ltd) invited bids for implementation of DF (distribution franchisee) system in Bhiwandi. TPL (Torrent Power Ltd) was selected as the distribution franchisee (at a levelised bid value of Rs. 2.04/kWh) for 10 years. TPL focused on augmentation of the distribution network and proper supply of electricity to the consumers. It took various steps to improve the distribution system in Bhiwandi such as replacement of DTs, installation of meters, replacement of overhead line conductor, revamping of LT (low tension) line network, establishment of 24-hour call centre and 24-hour fault attendance centre etc. This resulted in the reduction of AT&C losses from 60% in 2006 to 24% in 2009, increase of collection efficiency from 68% to 88% during the same period and decline of DT failure rate from 40% to 7.5%.

Source: TERI, 2010

Following the success of the Bhiwandi model, other states of India such as Uttar Pradesh, Madhya Pradesh, Rajasthan, Bihar and Haryana are also planning to adopt franchisee model for electricity distribution in certain areas. The evidence from India seems to suggest that the franchisee model has been found to be successful. Recent TERI studies on evaluation of franchisees in the rural areas of selected districts of Assam, Karnataka and Madhya Pradesh show that the franchisee model has generated avenues for business and employment for the local people, resulted in reduction of customer grievances and contributed to the socio-economic development of the regions. It has also improved the revenue realization and led to reduction in thefts and pilferage (TERI, 2007).

The franchisee model however is grappling with certain challenges that need to be addressed for it to realize its full potential in functioning as a sustainable participatory model. Franchising may bring in private sector efficiency, investments in the distribution network, reduce loss levels and improve collection efficiency but their financial sustainability also depends on the load mix that they cater to. In case of Bhiwandi, it needs to be noted that the franchisee primarily served the industrial consumers, who are high revenue base consumers. The same may not hold true for rural consumers who generally cannot afford to pay high tariffs. The study undertaken by TERI also reveals that one of the other risks that a

franchisee faces is in terms of short duration of contracts. The contract duration for franchisees is seldom adequate for them to invest in the distribution network and reap positive returns from the same (TERI, 2010)[5]. A franchisee wanting to manage the distribution and retail supply activities in the franchised area would require a whole set of technical, commercial, and managerial skills, the availability of which may be an issue in the rural areas, at least initially (Bhattacharya and Srivastava, 2009). Franchising may prove to be a win-win case, provided the operational and financial risks associated with the model are carefully considered while analyzing the feasibility of the model. The table below summarizes the strengths and weaknesses associated with this model.

Table *2: Strengths and weaknesses of the franchisee model*

Strengths	• Focussed attention to electrification of rural areas thereby increasing the pace of rural electrification. • Investments in the distribution network in the franchised area which are usually remotely located and are neglected by the distribution licensees. This helps in bringing down losses and stepping up revenues. • Creation of employment opportunities in the rural areas as franchisees generally employ the local youth for services like bill collection, meter reading, maintenance of LT lines, fuse off calls etc. • Better customer service and grievance redressal as compared to the distribution company. • Political fallouts associated with full privatization are not involved in the franchisee model since the distribution assets stay under the control of the distribution company, while it also simultaneously allows for benefits of private sector efficiency to come in.
Weaknesses	• Does not improve supply and the lack of predictable and demand-responsive supply is a barrier to attracting qualified franchise operators. • Short duration of contracts may act as a deterrent for private entities to invest in the distribution network • The possibility of franchisee defaulting on the payments could emerge as an issue unless contractual arrangements are enforced effectively. • Difficulty in having operational control over franchisee where large distribution zones are franchised (esp in the case of retail supply and distribution franchisee) which may create regulatory hurdles.

[5] For eg, the contract duration of Enzen Global in Orissa is five years.

4. Fee-for-service/ESCO models

The ESCO is a company that owns, installs and operates electricity systems (eg solar home systems, solar water heaters etc) and provides energy services to consumers.[6] The company is also responsible for repair and maintenance of the systems and providing replacement parts over the life of the service contract. The ESCO charges the users/beneficiaries a fixed monthly fee or leases the equipment to the consumers for a fixed rental fee, which is why the model is also known as fee-for-service model. The ESCO model has been found to be successful in some countries of Africa such as Zambia, Kenya as well as other nations such as Srilanka, Dominican Republic etc. Here we discuss cases from Zambia and India.

There are some fee-for-service models for solar home systems that are run by private companies such as Selco, Sunlabob etc. These have been separately discussed in the successive section on private sector models as these are purely commercial ventures which provide a range of products (e.g. solar homes systems, solar lanterns, solar water pumps etc.) using various financing models where in fee-for-service is just one of the options.

4.1 ESCO model in Zambia

The Zambia PV ESCO project was implemented by the Government of Zambia in 1998 as a pilot with the aim of applying the ESCO concept to diffuse solar technology. It was supported financially by the Swedish International Development Authority (SIDA), with the Stockholm Environment Institute (SEI) as advisors to the DoE (Gustavsson and Ellegard, 2004). The project has supported the formation and operation of three ESCOs in districts of Eastern Province of Zambia[7]. In all cases, the ESCO business is a subsidiary to an existing company with business activities in other fields: farm implements, waste management and a farmer's cooperative. The ESCOs are private companies and are licensed to do business and installation of solar equipment by the Energy Regulation Board (ERB). The ESCOs have a very small administrative set up consisting of a director/ project manager, two finance/administrative staff and two or three technicians (Lemaire, 2009).

In the ESCO scheme, the Zambian government buys solar photovoltaic systems that are then lent to the Energy Service Companies, which have up to 20 years to reimburse the loan from the government (initially a donation from SIDA). The ESCOs install solar equipment in households and small shops and charge an installation fee. Post installation they receive a monthly payment for the systems. A Fund is also created to replace the batteries regularly. This is a savings scheme, where part of the regular service fee is set aside in a bank account, in order to be able to purchase a new battery once the old one is exhausted.

Most of these ESCOs served a similar consumer mix which primarily comprised of farmers, civil servants, business people and schools. However a recent study states that many of the farmers and entrepreneurs have withdrawn from the scheme and now the ESCO caters mainly to the government servants as they have steady income stream (Lemaire, 2009). Several studies also indicate that there are tangible socio-economic benefits accruing from the solar home systems (SHS) such as educational benefits for school children who can study at night, extended business hours for shops etc. SHSs have also improved the quality

[6] ESCO can be a public or a private company.

[7] ESCOs are operating in the districts of Nyimba, Lundazi and Chipata in Eastern Province of Zambia.

of life of people who now have a better source of lighting and access to entertainment facilities such as black and white TV sets and radio cassette players.

The model has been running smoothly for several years now owing to various factors that have contributed to its success. There is a regular interaction between the ESCO and the customers, which enables the ESCO to take feedback from customers and act on their requests in a timely manner. The technicians of the ESCO visit the customers on a monthly basis to collect the fee, check the system for malfunctions and provide services which include – checking the acid level of the battery, cleaning the solar panels, visual inspection of the system installations, measuring the voltage over battery poles etc. There seem to be no vandalisms as the consumers have to face severe costs in accordance with the agreement that they sign with the company. These systems are kept in close control of the client's houses. Further are no local black markets for panels which may also be the reason for low incidence of thefts. The payment record of the consumers is also good due to the quality of the service provided by the ESCOs and immediate disconnection in case of non-payment.

The ESCO model also faced some challenges in terms overuse of the systems by the clients which resulted in blackouts. Some of the initial designs of the solar home systems also had technical limitations in terms of the quality of batteries and lamps. Lamps and lamp fittings were reported to break after a few operating hours. However, with the training of ESCOs' technicians and the dissemination of information to customers who are now aware of the possibilities and limits of their solar system, these initial technical difficulties have been solved to a great extent.

4.2 Fee-for service model, India

India also has an innovative fee-for-service model for solar lanterns, which has been evolved by TERI. TERI has evolved an innovative renting model for providing access to clean lighting through solar lantern under its LaBL campaign initiative. The campaign launched in 2008 aims to bring light into the lives of one billion rural people by displacing kerosene and paraffin lanterns with solar lighting devices, thereby facilitating education of children; providing better illumination and kerosene smoke free indoor environment for women to do household chores; and providing opportunities for livelihoods both at the individual and at village level.

LaBL operates on fee-for-service or rental model where Centralised Solar Lantern Charging Stations (SCS) are set-up in villages for charging the lanterns and providing the lanterns daily on rent to households and enterprises. A typical solar lantern charging station consists of 50 solar lanterns with five numbers of solar panels and junction boxes. The charging stations are operated and managed by entrepreneurs (Self Help Groups/individual youths) who qualify the selection criteria set as part of the LaBL campaign. These entrepreneurs are selected and provided the handholding support by local LaBL implementation partners called LaBL Partner Organization. The rent is collected by the entrepreneur, a part of which is used for O&M of the charging station and for replacement of battery as may be required after 18-24 months of operation. Till date, TERI has successfully extended the Campaign in around 600 villages spread across 15 states in India impacting more than 150 000 lives.

The LaBL initiative has successfully demonstrated in India how solar lanterns could impact the community; be it for lighting or for livelihood generation at the household and village level. The impact is not simply the provision of lighting purely in a physical sense, but is actually an instrument by which lives can be transformed and hopes and aspirations generated on a plane that clearly enhances human welfare substantially. There is direct livelihood benefit in the form of 'green jobs' for the entrepreneurs managing the SCS and earning through renting. The operators—more than 15% of whom are women—earn approximately Rs 1500–3500 per month by renting out lanterns. At the household level, the programme has been instrumental in encouraging children—particularly, the girl child, who is usually busy during the day with household activities— in opting for longer study hours. Apart from inducing a smoke-free indoor environment for women, there is improved mobility and safety after dusk for both women and the elderly. In addition, the programme is also advantageous to those who are using the lanterns to earn a living by way of weaving, sewing, vending, running tuition centers, and by providing other village level services.

Some of the key strengths and weaknesses of the fee-for-service model are as given in the table below:

Table *3: Strengths and weaknesses of the fee-for-service model*

Strengths	• The consumers do not have to raise capital to purchase technology upfront. As the ownership vests with the ESCO, paying monthly fees for the service works very well with the lower income strata populations in the rural areas. • Customer service has been found to be very good (eg replacement of batteries, charge controllers etc). ESCO staff regularly visits the households for operation and maintenance. • By aggregating the demand, ESCO can obtain favourable financing terms from donors, market based credit organizations etc which can be passed on to the consumers in form of lower service fees.
Weaknesses	• As the ESCO is responsible for almost the entire range of activities in the energy service value chain, one of the drawbacks that ESCO faces is availability of trained personnel with appropriate technical and business skills. • The risk of theft of systems is mainly carried by the ESCO and only partially by the user. • To ensure a full cost recovery mechanism, the ESCOs may target only the relatively affluent households within rural areas.

Source: TERI analysis

5. Community managed off- grid systems

Community management of supply systems is yet another service delivery model to serve isolated load centres. In such cases, a small generating plant is set up by the village committee/Panchayat/ NGO and a mini grid is created to serve either a village or a cluster of villages. Almost all renewable technology such as solar PV power plant, biomass gasifier based mini grid, mini hydro systems or hybrid (solar-gasifier, solar-diesel etc) has been attempted following this model. Micro hydro based developments in Sri Lanka and Nepal are considered to be successful initiatives, which are run by the local communities using the locally available water resource to meet their energy needs. On the other hand, the model has not been very successful for the biomass gasifier systems implemented under V*illage Energy Security Programme,* in India. Solar PV based projects implemented in India following the model have however been successful.

5.1 Village micro-hydro projects in Sri Lanka[8]

The growth of village micro-hydro schemes in Sri Lanka can be traced in two phases. Phase 1 saw the emergence of welfare oriented community projects, while the second phase was more market-oriented, driven primarily by the private sector (discussed in detail in the next section on private sector models).

In the first phase (early 90's), Intermediate Technology Sri Lanka (ITSL)[9], embarked on an innovative mode to provide electricity to rural households in Sri Lanka through micro-hydel based generation. As Sri Lanka is abundantly bestowed with rainfall, there is a great hydro potential to generate adequate power for household illumination. ITSL capitalised on this idea to provide rural electrification based on "community management". While the concept of micro hydro was not new in Sri Lanka, the micro-hydro turbines available in the open market had poor safety record. ITSL improved this technology by incorporating new developments and safety features.

ITSL first studied the electricity needs of a few off-grid communities with water sources and analysed the financial viability and economic benefits of micro hydro for village applications. Community management approach was adopted where in Electricity Consumer Societies (ECS), a village organization formed for development, function and maintenance of village hydro schemes. This was done to instil a sense of ownership among the communities. Further given the geographical location of these micro hydro sites, external agencies were not seen to be able to manage on a long term basis. Membership of ECS was essentially from the village. ECS functions as an autonomous body, responsible for raising funds, contributing labour, setting tariff structures and managing operation and maintenance. ECS was ably supported by the technical advisory committee of ITSL. A monthly fee of SL Rs 600/ household for a maximum usage of 100watts/household was fixed by the ECS. Tariff subsidies or free power were given to poor and invalids so that they will not be 'drop out' in the rural electrification process. Households were willing to donate ones share of power to households in need of extra power at times of social functions. These projects were functioning with aid from development organizations and donors.

In the second phase, the micro hydro projects were included in the World Bank ESD project. However, under the more 'commercial orientation' of the World Bank programme, the ECS were not eligible for loans and have to be converted into limited liability Electricity Consumer

[8] Ariyabandu, R, Upscaling Micro hydro a Success Story
[9] ITSL is a development charity based out of United Kingdom. It has now been rechristened as Practical Action.

Companies. The new model under ESD/RERED project allowed a 'project developer' to submit a proposal to the bank (DFCC) and on the strength of the proposal a loan is approved for implementation. ESC has to repay the loan with interest after a stipulated time. The new model denies the benefit of micro hydro schemes to poor households because of the high costs of generation and the technical limitation of transmitting power beyond 1.5 km. Households which can contribute towards the initial project costs, voluntary labour for civil works and pay for the internal wiring are favoured more in the new model. While initially the micro hydro model was only for lighting purposes, later on the concept of productive end uses was also introduced. Two main uses were - battery charging and grinding and paddy milling. However ECSs do not encourage day time productive end uses which consume substantial power, leading to power fluctuations and consequent disputes between high power users and normal users.

While these are minor setbacks, the village micro hydro model in Sri Lanka has by and large been successful with increased role of decentralized provincial institutions.

5.2 Village energy committees in India[10]

Village energy committee model has been tried out in some states in India with limited success. The Village Energy Security Programme (VESP) introduced by GoI also propagates the VEC (Village Energy Committee) model to manage off-grid projects at the village level. VESP was introduced to provide energy security in the villages through locally available biomass resources with full participation and ownership of the community and ensure enhanced livelihood and improved quality of life. The emphasis of the programme is on energy security at the village level with a further thrust on micro enterprise development for enhancing employment opportunity and economic viability of the projects. The test projects has been undertaken in un-electrified remote villages and hamlets that are not likely to be electrified through conventional means in the immediate future. Based on a community centric approach, a one time grant (up to 90% of the project cost) is provided to the village community for installation of energy systems capable of meeting the village community's energy demands. The community is also expected to provide an equity contribution either in cash or kind to bring in the much needed ownership, required for success of any community centric projects.

The service delivery model followed involves formation of a VEC by the Project Implementing Agency (PIA), with representations from villagers and the local governance body (panchayat). The VEC is constituted through the Gram Sabha and duly notified by the Gram Panchayat as a Sub-Committee of the Gram Panchayat as per the relevant provisions of the State Panchayati Raj Act and rules in this regard. The VEC usually consist of 9-13 members with 50% representation from women members and the elected Panchayat member from that village being the ex-officio members of the VEC.

The PIA sets up the energy production systems and hands over the hardware to the VEC for day to day operation and management. The VEC acts as custodian of the energy production system and is responsible for the operation and management of the systems. The electricity generated from the energy production systems is distributed to the community through a local mini-grid. The tariff is set by the VEC in consultation with the PIA in such a way that it takes care of the fuel and the O&M costs. The VEC is also responsible for arranging the biomass, either as contribution from the project beneficiaries on rotation basis or purchase of

[10] TERI, 2009a

biomass from the biomass collection agents such as self help groups. The VEC also creates energy plantation in the village forestland or community land to ensure sustainable supply of biomass. User charges are collected by the VEC to meet the operational expenses of the projects and VEC manages all the accounts in relation to the project.

Further, a Village Energy Fund is created by the VEC under the provisions of State Panchayati Raj Act, initially with beneficiary contributions for sustained operation and management of the project. The monthly user charges from the energy users are deposited in this account. The Fund is managed by the VEC with two signatories nominated by the Committee. One of the signatories is the Gram Panchayat member and the other signatory is the President or Secretary of the VEC. In short, it can be said that VEC plays the role of stand-alone power producer, distributor and supplier of electricity, manages the revenue through collection of payments for the electricity used from users and dispute resolution in case of power supply disruption.

TERI's study in 2009 found out that despite a holistic approach with sound basis, VESP is finding it difficult to achieve desired goal/success due to certain weaknesses (TERI 2009a). Due to less concentrated electricity demand in the villages where VESP projects are operational, low paying capacity of the consumers, difficulty in O&M, limited technical knowledge of VEC and weak fuel supply chain linkages, the VESP projects are encountering issues of sustainability. One or combination of the above factors is leading to low load and less hours of operation. The combined effect is thus very low capacity utilisation factor and hence higher unit cost of energy production resulting in low economic viability of the energy production systems. Further there is lack of clarity in the roles and responsibilities among the different stakeholders: PIAs, state nodal agencies and VECs. The coordination committee meetings between stakeholders are seldom held and advantage of technical expertise with state nodal agencies is not fully tapped. Community participation is not optimum owing to host of factors such as poor training and handholding support given to VECs to operate the project, poor leadership of the VECs and low level of delegation of activities to the VECs.

However, there are certain good examples as well for the community based model in India. For e.g., the community SPV systems installed by Chhattisgarh State Renewable Energy Development Agency (CREDA), are also managed by village energy committees. Here, CREDA is the nodal agency for implementing the community solar PV projects and responsible for overall monitoring of the projects. It identifies the suppliers who are responsible for the design, construction and execution of the solar PV plants. An annual maintenance contract is entered between CREDA and the supplier. At the next level in the service delivery chain is the operator, who is responsible for the operation of the plant (switch on and switch off, cleaning of the modules etc) and lastly there are master technicians who take care of the preventive and breakdown maintenance of the plants. The village committees are formed at the village level to enure community participation in the project, handle grievances of the community and act as the interface between the CREDA and the community. In this case it has been seen that model has been successful as there is an expert agency taking care of the operation and maintenance and there are local level technicians to handle preventive maintenance such as fuse off calls etc, which was found to be lacking in the VEC model under VESP.

The strengths and weaknesses of the community managed model are given in the table below:

Table 4*: Strengths and weaknesses of the community managed model*

Strengths	• Decentralized approach of management by involving communities brings in a sense of ownership and builds accountability. • Provides employment opportunities to the local youth to get trained in O&M of the off-grid systems. • Communities with socially progressive and cohesive structures are seen to be able to manage the entire range of activities –power generation, O&M, delivery, revenue collection, dispute resolution well if they are successfully mobilized by an NGO or other appropriate bodies. • Productive end uses application helps in improving incomes of the rural population.
Weaknesses	• Without proper mobilization of the communities and proper training and handholding support during the initial phase, this model may not be sustainable. • Revenue management is often seen to be poor wherein the beneficiaries who do not pay are not penalised because of local compulsion. • Without productive end uses applications at the local level, community managed projects tend to become defunct in the long run.

Source: TERI analysis

6. Private Sector Models

Some of the most promising models for scaling up off-grid energy involve private companies experimenting with profiting from building rural energy infrastructure and/or selling rural electricity. In these models, a for-profit entity arranges and manages an implementation model (often using one specific technology), identifies suitable villages, builds the electricity supply, and arranges for operations and maintenance, often with the help of local partners. In general, the private-sector space is undeveloped, perhaps because of the high risk and relative instability of the market. Yet the recent World Resources Institute and CDF-IFMR report *Power to the People* identifies an enormous potential $2+ billion market in decentralized renewable energy, and a number of companies are actively experimenting in the space.

There are many variants of the private sector models of electrification. Each of the models is discussed separately in this section:

6.1 Public Private Partnerships

A large number of the private models implemented to-date has used a private model paired with government resources to support their initiatives. These models develop a business plan that relies either on government subsidy or support to make the cost calculation effective, but are implemented through private agents. For example, some models have used government funding to support capital construction of a power plant or charging station, but a partial-private model that uses power revenues to pay for operations and maintenance.

India – Scatac Solar

One company drawing such attention is SCATEC Solar, a Norwegian solar manufacturer. SCATEC has electrified 30 pilot villages in Uttar Pradesh, Jharkand and Madya Pradesh. The company's model focuses on profiting from manufacturing small-scale solar power plants and building village scale mini-grids. SCATEC attempts to use revenue from selling the power to pay for operations and maintenance of local plants. The plants are built using funds from the Government of India as well as Norwegian Development Aid. Models have been tested that focus on primarily household lighting, as well as those that generate economic revenue, such as through silk reeling in Jharkand. The company builds plants and infrastructure at a relatively expensive cost to insure minimal maintenance. Its marketing strategy, which will be evaluated after the current pilot phase, argues for the role of solar mini-grids in cost-effectively generating demand for electricity sufficient to generate the demand for other sources, including grid electricity.

Philippines- Qualified Third Party

The Qualified third party (QTP) model of Philippines is an innovative approach to extend electrification to off grid areas. The QTP refers to the alternative electric service provider authorized to serve remote and unviable areas. The QTPs may include private firms, local government units (LGUs), cooperatives, NGOs, generation companies or their subsidiaries or subsidiaries of Distribution Utilities (DU). For remote barangays[11] the provision of electricity services operated by QTPs usually includes mini - or micro-grids based on diesel or micro-hydro. Recognizing that consumers in these off-grid areas cannot afford payments

[11] Barangay is the native Filipino term for a village, district or ward

that reflect the true cost of generation, the new regulatory framework provides for regulated generation rates based on affordability. The power supplier is selected through a competitive bidding process and the one offering the lowest generation rate is awarded the contract. This rate is adjusted over time to reflect changes in fixed and variable costs of generation. Based on the general framework, the electric cooperatives are allowed to charge the above-agreed rate for the generation component of the consumer's electricity charges. However, if the true cost of generation rate is higher, the new power provider is reimbursed for the difference, on the basis of kilowatt-hours supplied from a Subsidy Fund. Thus the QTPs are required to adopt the least cost and most efficient technology options in serving the unviable areas. In selecting the QTP, preference is given to those entities that can offer the least-cost technologies utilizing renewable energy sources (TERI, 2008).

Currently, QTP model has been adopted for stepping up rural electrification in Philippines is the primary vehicle used for off-grid electrification with private-sector participation and covers remote areas that the distribution utilities waives off as financially unviable for the utility to serve. The DoE has also published the list of waived areas in the country for taking up by potential QTP's. The private sector is invited to provide long-term service to the customers within the market package for the contracted period (i.e., about 15 to 20 years). The selection of the QTPs are done based on the conduct of competitive bidding where the QTP is such selected that they exhibit a lowest subsidy requirement or has the lowest level of tariff.

PowerSource Inc. is one of the QTPs operating in Rio Tuba, Bataraza, Palawan since 2005. It runs two 210kW diesel generators into a local mini-grid in the Rio Tuba area, and also applies selected solar home systems in particularly remote locations. The company sells power directly to customers at a fixed rate. The project is an example of a public-private partnership involving the Department of Energy (DoE), KEPCO, the Palawan Electric Cooperative (PALECO), and PowerSource Philippines, Inc. (PPI), and is serving 1,132 households 24 hours a day and 7 days a week. The project also recovers US$0.26/kWh from the subsidy fund as the difference between the full cost recovery rate (US$0.44/kWh) and the socially acceptable retail rate (US$0.18/kWh), which is the existing tariff. A second unrelated pilot project, PAMATEC for Maasbate PRES, is also ongoing. Status and success of these efforts remains to be seen.

Laos - Solar lantern rental system of Sunlabob [12]

Sunlabob is a Laos based commercial company which operates as a profitable, full-service energy-provider selling hardware and providing commercially viable energy services for remote areas where the public electricity grid does not yet reach. It provides a range of products such as solar PV systems, solar heaters, lighting systems, hybrid systems etc. Solar lanterns are one of the important applications developed by Sunlabob that has had a significant impact at the grassroots level. The Solar Lantern Rental System (SLRS) is an innovative public private partnership wherein Sunlabob has partnered with the local village entrepreneurs and village energy committees to deliver lighting services to the community.

Sunlabob has developed a package whereby a village entrepreneur operates a large solar charging station rented from Sunlabob. The solar charging stations are installed somewhere at a centrally accessible location. The entrepreneur then charges portable lamps belonging to him/her, which can circulate in the households of the villages. Such lamps are compact units that villagers can hang up inside a room or easily carry, including a rechargeable battery. Each lamp is set to have light for 10 hours. The households only pay a refundable

[12] (1) Energy and climate change in cold regions of Asia, Seminar Proceedings, 2009 (2) http://www.sunlabob.com/solar-lantern.html accessed on 7th March 2011

deposit and a discharging-fee, which makes it affordable to them. For each recharging the entrepreneur collects a fee. All collected fees together cover all the costs of operating the whole system on a commercial basis. The recharging fee for the solar lanterns is based on local kerosene prices and rural households' incomes.

The village entrepreneurs who rent the charging stations from Sunlabob are in a franchise agreement with Sunlabob. This franchise encompasses the installation of the charging station, regular servicing of the charging station, sale of lantern units, and replacements for their components, regular trainings for maintaining quality and implementing emerging technical advances, operational advice, business advice, assistance in local marketing, demonstrations and campaigns, assistance in accessing soft loans etc.

The model has resulted in an improvement in the economic development of the villages. Renting and operating a recharging station is a sustainable village based enterprise, technically and operationally safeguarded by a franchise arrangement with Sunlabob. The village entrepreneur may not make a living just from operating a charging station, but it will be a regular and reliable income that can fit with other income streams.

6.2 Purely Private Models

For-profit companies are leading electrification through two primary revenue models – one which looks to profit from selling electricity to local consumers, and another which looks to profit from capital costs of setting up off-grid energy infrastructure and simultaneously establish a sustainable operations and management of those plants using power revenue. Two successful examples of private sector models are discussed below:

a) Husk Power Systems (HPS), India

HPS is a small start-up company based in Bihar, has one of the most widely recognized models, and has electrified about 80 villages since 2007, affecting nearly 25,000 households, with plans to expand to 6,500 villages by 2014. HPS builds village scale mini-grids using rice husk gasifiers, usually ranging between 30 and 200 kW systems. HPS works only in locations where at least 250 households agree to take connection and it charges a nominal installation charge as well as a regular fee for electricity, sometimes 45 INR per 15 W CFL. It charges a higher rate for commercial use than for residential use. Some of its plants have generated INR 40,000 monthly revenue from tariffs, considerably greater than average expenses of INR 20-25,000/month.

HPS's operation focuses on local community participation and a number of synergies which enable it to profitably sell power to villagers. Revenue from villagers' electricity use pays for the operations of the plant and there is enough profit to pay back the large upfront costs to build the biomass plant. The favourable economics result from a number of specific innovations. For instance, HPS builds rice mill alongside its plant, using surplus power capacity from its power plant to run the mills. It offers free milling to local farmers in exchange for using the rice husks to feed the power plant. As a result it has reduced its fuel costs and simultaneously provided local benefit. HPS also employs local entrepreneurs to manage plant upkeep and collection. The company has secured significant seed investments from primarily social venture funds, such as Acumen Fund, the Shell Foundation, and Bamboo Capital.

b) SELCO, India

Bangalore-based SELCO has made a name for itself selling, servicing and financing nearly 100,000 single home systems since 1995. A typical system uses a single PV module to power four 7W compact fluorescent lights (CFLs). While the core business of SELCO is design and sale of solar PV systems, SELCO also offers an array of solar lighting, water heaters, cookstoves and other products. Core to its business model are innovative finance and loan mechanisms which support consumers to purchase the relatively expensive systems. The company plans to sell an additional 200,000 systems in the next four years.

SELCO does not provide credit or loans, but has built up working relationships with local banks and microfinance organisations over many years. This has given finance organisations the confidence to provide credit for PV systems, and an understanding of the payment terms which different owners may need. Some users work directly with the finance organisations, others work through self-help-groups which provide additional security that a loan will be repaid.[13]

The main work of SELCO is carried out by local service centres, with the aim that all customers should be within three hours travelling distance of a centre. All installations and user training are carried out by SELCO technicians. Service is free during the first year, and SELCO staff visit each system every three months to make sure that it is working correctly. PV modules supplied by SELCO come with a 10-year guarantee and batteries with a 3-year guarantee: any faults are reported to the SELCO head office, which keep details of all systems, so that problems with suppliers can be tracked quickly.

The private sector off-grid electricity space also appears to have extremely low barriers to entry for new entrepreneurs. For example, Mera Gao Micro Grid Power, a small start-up in India, have invested approximately $11,000 into building several pilot solar-power plants in small villages in Uttar Pradesh. The model focuses on implementing the full energy system – generation, battery storage, distribution lines, and LED lamps. MGP charges customers a flat rate of Rs 100 and Rs 150 for 2 or 4 lights respectively. Their core innovation is profiting from the low cost power delivery of LED lights. While the organization's work is only in its initial state in 3 pilot villages, particularly noteworthy is the ability for entrepreneurs to enter the space without investor or corporate backing.

c) Rural Electricity Entrepreneurs and Battery charging stations, Cambodia[14]

Cambodia's power supply facility covers only about 20 % of the total population. Of this, 13% is by EdC (Electricite du Cambodge), which is the national electricity company and essentially covers the capital city Phon Penh and other provincial towns and cities; 7% by REEs (Rural Electricity Entrepreneurs). The REEs own 1-2 small diesel generators, and distribute electricity through their own small network (low-voltage distribution lines) to local households. It is reported that there are around 600 to 1,000 Rural Electricity Enterprises (REE) supplying different power services in rural areas catering to an estimated 60,000 households. The electricity supplied by mini grid is used to supply power to 2 CFLs and 1

[13] www.ashdenawards.org/winners/selco07 accessed on 12th February 2011.
[14] TERI, 2009b

TV. Electricity is only supplied for limited hours in the rural area and there is frequent power failure due to poor facilities. In fact the tariffs are also higher ranging from 30 cents/ Kwh to 90 cents/ Kwh. This can be partly attributed to the large use of old small generators, reliance on fully imported diesel fuel, and large losses in low quality medium voltage distribution systems.

Apart from diesel mini grids, battery charging stations (BCS) based on diesel generators is also very common in Cambodia. Between 50% and 75% of the Cambodian in rural area get access to electricity by batteries. The communities buy the batteries and get them recharged by a local entrepreneur in the village. The equipment at the BCS is kept at the strict minimum. In general they make use of old diesel gensets and on average charges 50-100 batteries in day, with an average charging time of 7-8 hours. Each of such battery charging stations caters to 2-3 villages. The type of batteries is shallow cycle lead acid, which is normally designed and used for vehicles. The sizes of batteries are 50 Ah, 70 Ah, 100 Ah and 5 Ah. Batteries are used to supply electricity for home lighting and run TV, video, etc. In general, 50 Ah battery is used for home lighting, 70 Ah for lighting and running TV, and 100 Ah for running VCD/DVD set. Small size batteries are used often for a head lamp to catch frogs, birds, insects and so on. The price of recharge varies from 1000 Rials (0.25 US$) for a 40 Ah battery to 2000 Rials (0.5 US$) for a battery of 100 Ah. The batteries are usually recharged at an interval of 2-3 days depending on the usage pattern. However, both these models have pollution related concerns apart from other issues such as high fuel costs, inefficiencies in the system etc.

d) Consumer credit model, Sri Lanka[15]

Sri Lanka has witnessed a rapid growth in the SHS market which is mainly driven by the private sector, and is supported by the World Bank, Global Environment Facility (GEF) and local financial institutions. This private sector led imitative is part of Sri Lanka's Renewable Energy for Rural Economic Development programme (RERED) and its predecessor Energy Services Delivery Project (ESD)[16] whose aim is to complement grid-based extension by the Ceylon Electricity Board, the country's vertically-integrated national utility. The program supports the provision of on and off-grid electricity services and socio-economic development in rural areas through hydro, solar PV, wind and biomass renewable energy technologies.

The project's centre piece is a market-based credit program available to Participating Credit Institutions (PCIs) - commercial banks, microfinance institutions, and leasing companies that meet the eligibility criteria (Govindarajulu et al, 2008). The Administrative Unit (AU) of the Development Finance Corporation of Ceylon Bank functions as the implementing agency on behalf of Government of Sri Lanka. The AU administers the IDA credit line to PCIs which in-turn lends these proceeds along with complimentary financing from their own resources to eligible sub borrowers such as project developers, community based organisations, end users etc. The AU also administers the GEF grant funds available for co-financing off-grid subprojects, preparing off-grid community based subprojects, developing new applications etc.

The PCIs can refinance up to 80 percent of their loan disbursements. PCIs use their standard procedures to appraise subprojects, establish creditworthiness and negotiate

[15] Nagendran, J. , Financing Small Scale Renewable Energy Development In Sri Lanka
[16] The duration of RERED project is from 2003-2010, while that of ESD was from 1997-2002.

lending terms with their customers. They also assume full credit risk on sub-loans disbursed to subprojects and must repay them according to an agreed-on amortization schedule, regardless of whether their borrowers repay.

In this programme, the AU has a very significant role to play in managing the credit programme. The systems installed under the programme are required to meet global quality standards. This is monitored by the AU thus providing the basis for consumer education and protection. The AU also approves loans contingent on evidence of installation (for SHS) or design approval by a chartered engineer (for village hydropower systems). Beyond its quality assurance role, it facilitates stakeholder interactions to solve implementation problems. The AU also ensures that the project takes off and leads to concrete results by tying the payments to pre-defined milestones. Such an output based approach has resulted in increased private sector participation.

For SHS, the financing model is consumer credit, through the micro- finance institutions that work closely with solar companies. Via their dealer networks, the solar companies sell SHSs and offer operation and maintenance services. Poor service by the solar company can lead to dissatisfaction in customer and a breakdown in loan repayment. Hence, PCIs who provide micro credit establish a memorandum of understanding with the solar companies, typically covering aspects such as minimum service levels, repossession of the solar panel on foreclosure and buyback in the event of a grid expansion. This leads to a tripartite arrangement involving the PCI, solar company and the end user.

e) IDCOL Solar home system programme, Bangladesh[17]

A similar programme namely the IDCOL Solar home system programme in Bangladesh was launched in 2003 for the installation of SHS at the household level. This programme has been supported by the World Bank's International Development Agency (IDA) and GEF and is administered by IDCOL – a non banking financial institution. IDCOL implement's the project through its 23 partner organizations (POs) including Grammen Shakti and BRAC. The IDCOL is responsible for providing grants and refinance the systems, sets the technical specifications for the solar equipment, develops publicity materials, provides training for PO capacity building and monitors PO performance. The role of PO is to select the project areas and potential customers, offer micro-financing to the customers, install the systems, provide maintenance support, ensure that spare parts are available, consultation with the users before installation, disseminate knowledge for productive use of the system, and to provide training to the users and local technician in order to create local expertise and ownership on the system. IDCOL offers refinancing through soft loans (6% interest with 2 years grace period and 10 years maturity) to the POs and channels grants to reduce the SHSs costs as well as support the institutional development of the POs. In addition, the IDCOL also provides technical, logistic, promotional and training assistance to the POs. The POs provide credit to the customers. A customer has to pay 10% of the total cost of the system as down payment and the outstanding amount is to be paid in monthly instalment with a 12% service charge, which covers the maintenance cost of the system. The programme has been immensely successful with deployment of more than 680,000 SHSs (as on September 2010), lighting the lives of about 3.4 million people. IDCOL has set a target of 2.5 million SHS by 2014. Currently, an average of 30,000 SHSs is installed per month, lighting the lives of about 150,000 people.

[17] IDCOL 2010

The key strengths and weaknesses of the private sector models are given in the table below:

Table *5: Strengths and weaknesses of the private sector models*

Strengths	• For-profit model has the ability to scale widely • Single companies act as the driving force for starting new projects • Private sector competition can lead to innovation and ability to experiment easily with new models • Low barriers to entry for individual entrepreneurs
Weaknesses	• Decentralized rural electricity is a risky investment, so few major investors other than "socially-motivated" have entered the space. • Profit-centred model means community needs could be neglected • Current economics generally not viable – companies need to rely on government subsidies or other inputs to drive business

7. Way forward

This paper has reviewed a number of alternative business models for rural electricity supply that have been reported in the literature. From the review, it is observed that the business models for rural electrification projects vary from country to country depending upon the resource availability, load profile, consumer's willingness to pay, techno-economic viability and social structures etc. It is also well-recognized that it is not possible to narrow down to a single approach to participatory models that can be considered for our research work on off-grid electricity access provision in South Asia. However, we find that for any model to be sustainable, scalable and socially acceptable, there are certain pre-requisites that need to be fulfilled.

7.1 Choice of appropriate business models

The key features which are essential for any participatory rural electrification model are as follows:

- ✓ **Choice of technology & demand estimation:** The suitability of a technology for a particular area would depend upon the availability of resources, the consumption pattern of consumers and degree of dispersion of the population. If it is a highly dispersed population and main electricity usage is only lighting then stand alone systems based on solar, is most suitable while for concentrated populations with some productive load, village mini grids is more appropriate. Small renewable energy plants with capacity of 25-40kW can be viable if they select an ideal area of operation, as demonstrated by the business models of Husk Power Systems. On the other hand, the 10-kW biomass gasifier has not been that successful under VESP as the capacity was inadequate to run productive loads, but was excess for only lighting load in areas where it been implemented.

  Further, for many rural communities, especially in remote areas, there may be visible need for electricity, but often with low levels of dispensable income and irregular income streams. Unfortunately, while the investor and entrepreneurs may see an exciting market opportunity in this suppressed need, need for electricity solutions does not necessarily translate into ability to pay or demand in the open market place. This, combined with the need for plants to maintain a certain plant load factor to not operate in a loss, underscores the needs for careful demand estimation while selecting target villages. The LaBL or the HPS model has been successful as they conduct a scoping survey to estimate the likely demand for lighting and ability to pay and sizes the plant/operation accordingly. The technology choice should best be compared with alternative options to arrive at the most favourable least cost option for a particular demand.

- ✓ **Financing:** As seen from the review, there are a number of financing mechanisms available to support rural electrification projects. Finance for project developers on favourable terms is a necessity for off-grid projects as they typically involve large upfront costs. A World Bank study has clearly demonstrated that financial subsidy is an important component of most rural electrification projects, at least in the initial years (The World Bank 2010). Financing can range from consumer financing, subsidies, grants etc. to market development finance given to the companies in the

supply– chain[18]. For large scale programmes such as company-to company lines of credit, it is extremely important that timely disbursement of funds to companies installing/operating off-grid systems is ensured. However, ex-post subsidies or payments which are released only after a project has been completed and is running well have also shown good results. Because of the unique situation of every off grid project, there is no 'one-size fits all' approach for financing. Experience also suggests that contribution solicited from the direct beneficiary of the projects (e.g. the local community) helps to foster a sense of project ownership in the community.

- ✓ **Electricity tariffs:** As affordability is one of the key factors from a customer's perspective, the electricity tariffs should be based on the 'ability/willingness to pay' of rural consumers. Willingness to pay and affordability are influenced by variety of factors such as trust, flexibility and frequency of payment schedules, proximity to payment points and quality of customer service.

  As many rural consumers still perceive off-grid to be the second best solution in comparison to grid connectivity, it is vital to spell out the tangible and intangible benefits which off-grid electrification may offer. Building trust and community 'buy-in' is therefore important to induce the communities to pay for electricity. In communities with variable cash flows, flexibility in payment schedule is critical. Payments should of right size to justify a trip to the payment point and not too high to be a barrier. In case of HPS, they sell electricity directly to consumers and sets the price of electricity to the users projected use and estimated ability to pay. Similarly, SELCO design the solar home system capacity based on the household's ability to pay thereby ensuring that the user pay the instalments in time. Proximity to payment/collection centres is again a relevant factor as higher transportation costs can discourage bill payment and may lead consumers to default on payments. The rural electricity distribution franchisee model is a case to this point. Where the collection efficiency used to be low when state owned utility was managing the rural electricity distribution, the franchisees provided the facility to the user to pay at their door step, which also contributed to higher collection efficient among other reasons.

- ✓ **Service delivery:**

  Operational and financial sustainability

  Despite having a sound conceptual design of an off-grid project, they encounter challenges in terms of operational sustainability. One of the lessons learned from the review is without a robust supply chain and post installation maintenance facilities, off grid projects don't deliver. VESP project in India faced a number of difficulties as there were weak fuel supply linkages along with limited maintenance facility, which was found to be a key constraint for the uptime of the biomass gasification plants. On the other hand, community model was successful in case of solar PV plant implemented by CREDA or WBREDA as the operation and maintenance was done through trained local persons and not handed over to the community.

  Regardless of the type of institutional model, unless a project is able to recover atleast its operation and maintenance costs, it is highly unlikely to be sustainable. Experience shows that models which provide for productive applications, find more customers and concentrate customers closer together are the most successful

[18] Supply-chain refers to the actors in the supply chain of RETs such as manufacturers, dealers, equipment importers etc.

models. Further many off-grid projects serve some of the poorest members, whose ability to pay for electricity is limited. Overoptimistic assumptions about revenue collection, inadequate working capital are ever-present hazards. Thus it is important that a realistic assessment is made during the design of the project. In case, the project does not sustain the project cost, maintenance will lag, fuel supply chain will be weak and difficult to assure, reliability of service will be poor and time consuming and eventually the project will fail. In such a scenario, the QTP program demonstrate that viability gap funding, provided as an output based aid, can possibly address the sustainability issue.

Management

Any participatory service delivery model can be successful only if it has a well defined administrative structure and effective management at the local level. There should be well-trained technical, administrative and support staff to run the business on a day-to-day basis. Well laid out procedures and set processes should be developed and followed. Revenue management which has been found to be a weak link in invariably many of the service delivery models needs to be strengthened. Proper accounting records should be maintained and service level benchmarks should be developed. A case in point is the Bangladesh PBS model, where there are pre-defined performance benchmarks which push the cooperative to strive towards better performance every year.

Community participation

Organizations with fewer layers and greater community interaction seem to work well and have the potential to scale up. Only those institutions which can successfully mobilize the communities by engaging with them can be sustainable in the long run. Women's groups and local farmers associations should be involved in the project development process. Voluntary labour (or "sweat equity") and capital contribution by the communities in design and implementation of a project also brings in a sense of ownership. It has also been seen that models which leverage local expertise seem to perform very well as local persons know the service area much better and are able to respond to community needs effectively. In fact private models with community involvement can perform very well as seen in the case of Laos (Solar lantern rental system).

Customer service

Customer service is one of the key aspects of a successful participatory model. The quality of customer service also influences the willingness to pay. As rural consumers are not educated, they desire a service provider who provides regular repair and maintenance services and has a good grievance redressal mechanism to resolve any disputes.

- ✓ **Socio-economic benefits:** The model should have visible socio-economic benefits, be it improvement in rural incomes, educational benefits, health care implications etc. To ensure this, the model should cater to productive applications in addition to domestic end use. A monitoring unit should be set up by the respective state government/ nodal agency to oversee the working of such projects. The unit should also undertake regular consumer surveys to quantify the socio-economic benefits of the project.

7.2 Concluding remarks

It is suggested that the development of framework should consider the above mentioned aspects while developing the business models for off grid electricity supply. While, this paper has restricted itself to the review of the selected business models and their relative strengths and weakness, going forward the framework analysis can attempt to test the to be framework for each of the model discussed here and analyse the results before the framework is ready for implementation through a demonstration project.

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Annexure 1: Supply Model Matrix for Electrification

	Grid	← Technology →	Offgrid
	grid extension	**village minigrid**	**single user system**
small, decentralised	Small grid reseller (India)	Diesel or hydro minigrid (Cambodia, Ethiopia) Hydro minigrids selling to local customers and to the main grid (China, Nicaragua) Formerly isolated minigrid now connected to grid, (Cambodia)	SHS (Honduras, Kenya, Indonesia, Sri Lanka) PV/wind/diesel water pumping (Brazil, Chile, Mexico) WHS or pico hydro (Argentina, Mongolia, Nepal)
private (for profit) large, central	Privatized concessionaire extends grid (Argentina, Chile, Guatemala, U	Offgrid concession (Argentina) Technology neutral electrification concession (Senegal)	SHS (Bangladesh, Bolivia, Morocco, South Africa)
Cooperative **Non governmental** other community organizations	Cooperative finances grid extension (Costa Rica, Bangladesh, US)	Multi-service Coop with diesel or hydro microgrid (Bangladesh, Bolivia, Philippines)	Agricultural Coop using diesel genset
	Small "community gateways"(Bolivia)	Community microgrids (Brazil, Cambodia, Honduras, Indonesia, Nicaragua, Sri Lanka)	Diesel genset or renewable energy to power a school, clinic, community center, etc.
small, decentralised	Small state-owned utility extends grid (Colombia, Brazil)	Municipal diesel or hydro minigrid (Bolivia)	
public large, central	State utility extends grid and sells at retail (Botswana, Mozambique, Thailand, Tunisia)	Residual state-owned isolated dieselminigrids with fuel subsidies (Nicaragua, Cambodia)	SHS (Mexico)