

Factors Affecting Renewable Energy Access in Rural India

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Abstract - This study presents the results of a preliminary attempt towards identifying potential areas where improvements can be made to boost the penetration of renewable energy products into rural markets in India. Major problems were identified to be lack of awareness about useful products, lack of supply due to scattered markets, higher product cost due to expensive logistics and lack of service centres. Considering the inputs from a pool of 1994 NGOs and 33 product manufacturers, a possible solution for this issue was collectivization of various minority groups to form distribution networks. Financial support can be provided through bank linkages and short term loans. The collectives need to be trained in not only distribution and sales of the products, but also its servicing which will ensure the sustainability of the business in the long run.

Keywords: *Entrepreneurship, Distribution network, Rural India, Renewable Energy*

I. INTRODUCTION

Renewable energy (RE) is a major asset to our daily lives. From a common calculator to a traffic light, we knowingly or unknowingly use solar products every day. But the use of this massive energy source isn't limited here. Almost every device we use has an RE substitute. This gives us an almost perennial energy source. Moreover, extensive research is being carried out in academia and research institutes to bring out new products continuously. But the existence of a product does not guarantee its availability. In 2017, approximately 70 percent of Indian population was rural (World Bank, 2018). But majority of business opportunities open up in urban areas, which leaves a large market still untapped.

Access to energy and development are closely linked. The definition of access is subjective. Considering one such definition of energy access by Ranjit (2002),

Access to modern energy can be defined as a household's ability to obtain an energy service, should it decide to do so. Access is a function of availability and affordability. For energy to be considered available to a household, the household must be within the economic connection and supply range of the energy network or supplier. Affordability refers to the ability of the household to pay the up-front connection cost (or first cost) and energy usage costs. A high up-front cost may discourage poor households from making a switch to a modern energy form.

One successful approach to improving renewable energy was the solar project piloted at Ghana, called Lighting Africa - a joint program by IFC and World Bank to accelerate the development of commercial off-grid lighting markets in Sub-Saharan Africa (Lighting Africa, 2010). Until 2010, there was no significant rural retail household PV market, with PV penetration only through "a stream of project based and contract based sales for health, education, telecommunications and other sectors" (Jim. F, 2009). Direct sales were limited to rich households and businesses. Prior to this, United Nations Development Program (UNDP) and Global Environment Facility (GEF) jointly started a fee-for-service model which was rejected due to lack of financial

sustainability caused by low monthly charges. (World Bank, 2007). To tackle these issues, (Nygaard, 2010) and lighting Africa identified the following areas in which work was necessary:

1. Demand – building consumer awareness on availability and benefits of solar products by providing information to targeted customers. Also, partial subsidies of the cost of equipment was provided.
2. Supply - strengthening technical capacities and supporting sensitization programs and outreach to rural areas by solar companies and their newly formed Association of Ghana Solar Industries (AGSI).
3. Quality – Verifying quality and satisfactory installation equipment through field inspection by qualified engineers. Also, provision of a three-year warranty for products.
4. Financing – Providing financing support through as line of credit and incentives to rural and community banks. Also, companies were provided finance to expand importation of equipment.
5. Facilitation – Conducting market survey; Financing salaries of Solar Project Officers to facilitate interaction between buyers and suppliers.

These initiatives provided a large boost for the solar home system in Ghana. The Indian rural market faces similar issues. The viability of the factors discussed above is studied for the Indian market in the following sections to understand the possibility of a similar model in India.

A. Demand

There is a severe lack of demand due to lack of awareness and promotion. People need to be educated in order to counteract any negative preconceptions or skepticisms regarding the usage of these products. Nearly 72 percent of the population lived in rural localities as of 2011 (ORGC, 2011). Apart from this, a majority is also considered to be living in energy poverty which means a reliance on traditional, more affordable biomass (IEA, 2012). This signifies the need of more awareness building measures.

B. Supply

There are hundreds of products developed in industries and academia every day that never see the markets. Even if they do, it is rarely in the rural markets. There are two major reasons for this. Firstly, it is impacted by publicity factors. A commodity which might be useful in a locality may not ideally get enough funding. There are entire technology sectors that exist, not because people want it, but because funders think people, or the world, needs them (Jue, 2015). The second reason is the presence of scattered markets in rural areas. This makes it difficult to supply the products at a significant profit. This requires the presence of alternative distribution channels for these markets.

C. Pricing

The average cost of solar home systems in India is under 50 percent of the price of a similar system in Ghana (Palit and Sarangi, 2011). But prices in rural areas is significantly higher

due to expensive logistics. According to a survey conducted in Maharashtra in 2011 among 10 villages, results showed that there is interest in using sustainable or renewable energy sources over more traditional methods. But affordability, reliability and ease of usage of the energy resource was highlighted by respondents as the most influential drivers for change (Blenkinsopp, Coles and Kirwan, 2013). This dictates the need of alternative pricing models, and better logistics. Another major issue is the lack of proper financing models. Incomes in rural areas are significantly lower than urban markets. But lower pricing is also not an alternative for this on the supplier side. Thus, new pricing models, alternative funding sources and subsidies are options worth considering. Even though direct subsidies for the capital costs of products and capacity-building of suppliers can be phased out after initial stimulation of the market, continued support for access to finance - on both supply and demand sides - and local facilitators may be needed to sustain growth of the market. (Steel et al., 2016)

From the available literature, we could understand that inefficient pricing models, lack of proper distribution channels and lack of awareness as the main problem. Professor CK Prahalad said that if there is indeed a “fortune at the bottom of a pyramid”, there ought to be an economically sustainable method to reach these potential customers (Prahalad, 2014). The aim of this research work is to find that sustainable method to access the market in rural India and provide an empowerment opportunity to the millions who live there.

II. RESEARCH METHODOLOGY

The research is designed as an investigation to gain insight into distribution methods and challenges for renewable energy products in rural India. Primary data was obtained using multiple surveys conducted among NGOs and companies operational in this sector. Literature review of past studies conducted in this area for markets in India and other developing countries was used as the secondary data.

For the first survey, a pool of 1994 NGOs operational in rural areas were contacted to fill out a survey form. The survey was sent through Email in the first phase. Approximately 12 percent of NGOs replied to the survey questionnaire.

Some of the main questions covered in the survey were:

- What are the main sources of income for the NGO and the target group?
- We enquired the level of awareness of people when it comes to renewable energy appliances such as solar lamps, small wind turbines, solar water heaters etc.
- The main preference for people while buying such products in rural areas, quality or price.
- Whether the NGO is involved in awareness spreading and training programs for such product.
- Do people in rural areas get lower quality products than people in urban areas?
- On a scale of 1-5, how tough is it to get a product serviced at the NGO's operational area, With 5 being very tough and 1 being convenient?

Apart from these questions, a few more questions were asked, such as operational area of the NGO, group to which the NGO caters, etc. The respondents that reverted were contacted through phone call in the second phase of the survey to get more details.

The second survey was conducted among 33 manufacturers who are operational in the renewable energy sector and are approved by the Ministry of New and Renewable Energy

(MNRE). These companies were contacted through email and phone call with most of them responding to the survey and the telephonic conversation.

Some of the questions covered in this survey were:

- What is the area of operation of the company (Rural /Urban)?
- What are the renewable energy products currently manufactured by the company?
- Structure of the distribution network. (Own network /Outsourced)?
- Is price of the products more important than quality in rural areas?
- Are some of the products specifically designed for rural markets?

Apart from this, companies were asked about their interest in expanding to rural markets. If no, what were the reasons holding them back, what do they need for such an expansion? Etc.

The results from these surveys were tabulated to get a clear picture of the present scenario and to provide possible recommendations and solutions.

III. RESULTS AND DISCUSSIONS

A. Introduction

From both the surveys conducted, a number of new problems emerged which were not justified during the literature survey. While there is a significant gap between the production and distribution, it is not just the distribution network that has issues but the manufacturing and accessibility too. The main problem areas are found to be awareness, accessibility, serviceability and an incongruity between manufacturers and companies on user preference i.e. quality or price also happens to be one of the major drawbacks in this industry. The profiles, target groups and areas of operations of the NGOs and manufacturers are discussed first before moving on to discuss the main problems in details.

B. Target groups and Areas of Operation

Out of the nearly 2000 NGOs that were interviewed, a majority were operational in the rural sector. Most of the NGOs in the urban sector were involved in either healthcare or the educational sector, while the scenario was different in the rural sector. There were various sectors in which the organizations were involved. Major sectors were:

- Agriculture
- Healthcare
- Tribal
- Women empowerment
- Skill Development

There were also NGOs that were operational in multiple sectors as well. A summary of the main operation sectors of the NGOs can be seen from figure 1. Apart from this, there are 27 NGOs which are directly working in the renewable energy sector, with activities such as training and awareness building.

We can see from figure 2 that maximum response was received from 5 states i.e. Uttar Pradesh, Maharashtra, Telangana, Orissa and Tamil Nadu. Other states in which the respondents work are Rajasthan, Andhra Pradesh, Bihar, Jharkhand, Madhya Pradesh, Delhi, Jammu and Kashmir, Assam, Haryana and Karnataka.

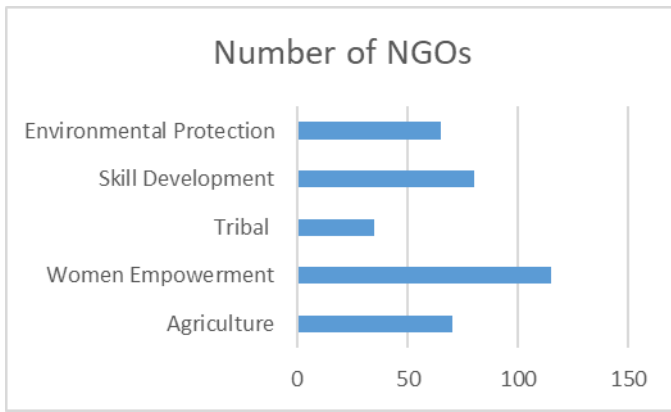


Figure 1. Operational sector distribution of NGOs

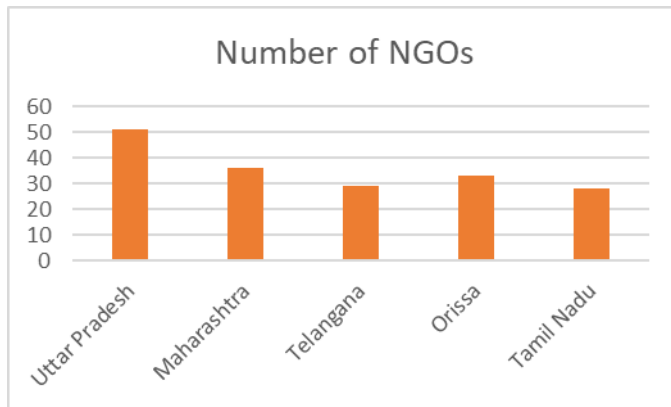


Figure 2. State-wise distribution of NGOs (top 5 most active states)

Initiatives taken up by most of the NGOs is also diverse. While a majority of NGOs were involved in the healthcare sector, there were many involved in conducting training programmes to open up new employment avenues. The major operations carried out by the NGOs are shown in figure 3.

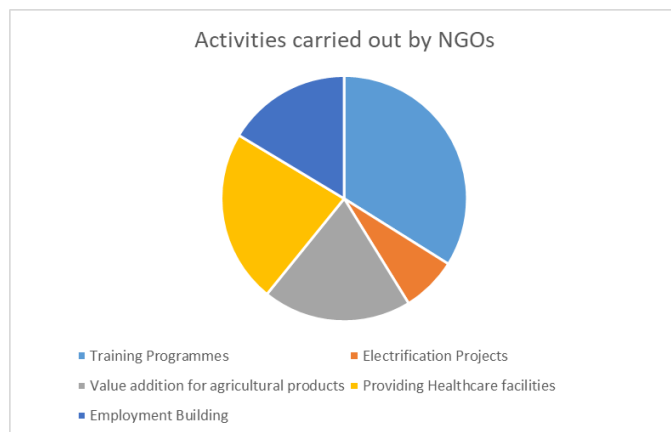


Figure 3: Summary of initiatives taken up by NGOs

1. Companies

When it comes to companies, the case is quite opposite. A majority of the companies are operational in the urban sector unlike NGOs. Data was collected from a pool of 31 companies. Table 1 provides the list of manufacturers with whom contact was established for the survey.

Table 1: Manufacturers of renewable energy products in India

S. NO	COMPANY	STATE
1	Agni Power	West Bengal
2	Ammini Solar	Kerala

3	Andromeda Energy Technologies	Telangana
4	Communications and systems engineering	Haryana
5	Environ Energy	West Bengal
6	Chloride power system	West Bengal
7	Gautam polymer	Delhi
8	Hilite enterprises	Uttar Pradesh
9	Jaiswal battery service	Uttar Pradesh
10	Kirti solar	West Bengal
11	maharishi solar	Uttar Pradesh
12	Kotak Urja	Karnataka
13	Orb energy	Karnataka
14	REIL	Rajasthan
15	Ritika Systems	Uttar Pradesh
16	Sanarti Incorporated	Delhi
17	SELCO Solar	Karnataka
18	Sigma Steel & Engineers	West Bengal
19	Su Solartech Systems	Punjab
20	Solex Energy	Gujarat
21	Sunshine Power Products	West Bengal
22	Coenergy Energy Systems	Karnataka
23	TATA Power Solar System	Karnataka
24	Thrive Energy Technologies	Telangana
25	Vikram Solar	West Bengal
26	Vimal Electronics	Gujarat
27	Jain Irrigation System Ltd.	Maharashtra
28	MIC Electronic	Telangana
29	Easy Photovoltech Pvt Ltd.	Delhi
30	SG Enterprise	Jharkhand
31	Pearl Enterprises	Maharashtra

Considering the state-wise distribution, maximum were from West Bengal. Other states that showed significant presence were Karnataka and Uttar Pradesh. Figure 1 shows the state-wise distribution of manufacturers. Even though the companies are based in these states, most of the companies operate in multiple states across the country, and some even outside the country.

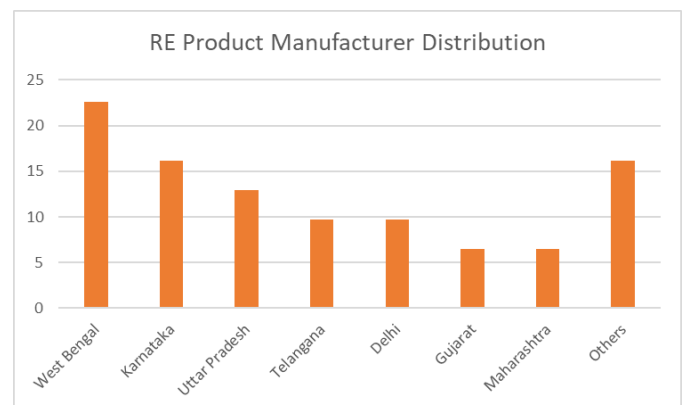


Figure 4: Distribution of renewable energy manufacturers across India

The major products manufactured by these companies are:

1. Solar rooftop photovoltaic (On-grid and Off-grid)
2. Home Lighting
3. Street Lighting
4. Water Pump
5. Solar Lantern
6. Water Heaters
7. Inverters

Other products are solar driers, cookers, batteries, air coolers, battery charger etc.

Majority of the manufacturers are working with rooftop photovoltaic, home lighting, street lighting etc. Most of the manufacturers work with multiple products. The distribution of manufacturer interest for the most popular products is shown in figure 5.

The subsequent sections will discuss the main challenges and problems faced by manufacturers, NGOs and people to start businesses in the renewable energy industry.

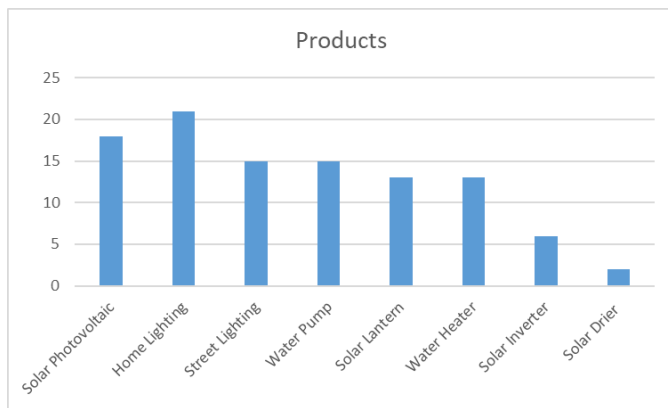


Figure 5: Most popular renewable energy products across India

C. Awareness

Awareness is the first and foremost problems when it comes to renewable energy. According to the survey results, there was a general lack of awareness regarding renewable energy products. Although most of the NGOs were aware of technologies like rooftop PV, most of them were unaware of other useful ones like solar water heater, solar driers etc. A majority of the organizations were completely unaware of possibility of implementation of hydroelectricity and wind energy at small scale. The awareness regarding each product can be seen from the figure. We can see that awareness is extremely low regarding some important products. The situation is even worse in a few states where organizations were not aware of such products at all. Thus, the first step towards promotion of renewable energy should be awareness building.

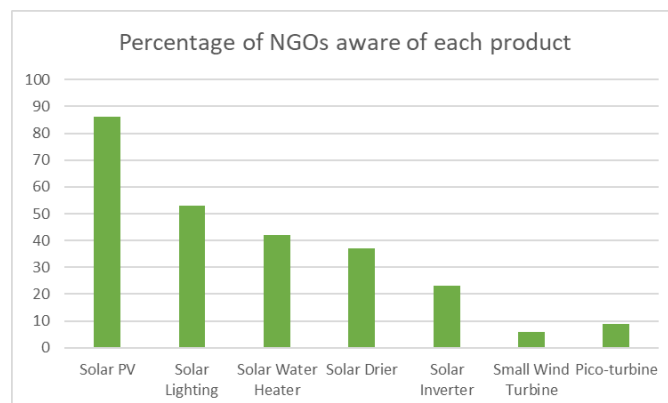


Figure 6: Proportion of NGOs that showed awareness regarding each product

It was understood by the survey data from the companies that though products are being sold in rural areas, hardly any activity is being taken up to raise awareness which eventually leads to skepticism and doubt from consumers towards the products. This surfaced up as another major problem in our studies.

D. Accessibility

Most signs of life disappear when sun goes down in rural India. Lacking electricity for even basic lighting, businesses close, children can no longer play outside, or even study indoors (1. UN India, 2018). One of the major reasons for this, stated by both NGOs and the companies alike, was accessibility. There are a large number of existing products in the renewable energy field but a majority of them are neither known nor accessible in rural areas. Most of the companies stated a lack of infrastructure as the major reason for limited operations. Apart from this, companies also stated that a scattered population made it difficult to set up a retail store or distribution center. The main reasons stated by the companies during the survey were:

1. Lack of infrastructure
2. Scattered population
3. More expense for logistics
4. Lack of enough trained people to carry out sales and marketing

NGOs stated a similar problem for their organization. Most of the organizations found it difficult to obtain products from companies at a large scale which prevented them from getting it to people. A lack of infrastructure and lack of roads connecting villages made logistics a trouble in most cases. NGOs themselves provided products in rural areas but this was also curbed due to limited resources to get the products to people.

E. Serviceability

The third major reason was serviceability, which is closely linked to accessibility. In a similar way that lack of skilled marketing and sales people curbs the accessibility of products, lack of technically skilled people denies people access to servicing for their product. Majority of the companies have their own network of service centres and service executives. But the network is not nearly as developed in rural sector as in urban.

There are 3 main factors that affect the reliability and interest of people in a product:

- Brand Value
- Quality
- Warranty/Guarantee

According to the NGOs, people first and foremost demand a common brand for the products that they use. This gives them assurance that the product is of superior quality and that service would be provided for the products. The main challenge for servicing in rural areas is the distance from the manufacturing unit. A scattered market does not make it profitable to assign a dedicated service person for a village. It would require a trusted network of service persons in order to make servicing convenient. Companies also showed interest in providing training classes for a set of people in order to make them independent when it comes to service. The third factor i.e. warranty/guarantee is also important as it makes people more interested in making the purchase. A warranty provides assurance for their product. A majority of the manufacturers provide warranty for their

products, some even upto 25 years. Awareness regarding such benefits would be highly propitious in raising the inclination of people towards these products.

F. Quality v/s Price

Another major factor was the understanding of companies regarding the actual necessity of people. There was a mismatch among the NGOs and the companies regarding the quality of product that needed to be manufactured for rural areas. While the NGOs represented people's opinion and said that people would prefer high quality of products, even if the price is slightly higher, the manufacturers exhibited an opposing view. Most of the companies produced products specifically for rural areas which were cheaper than their urban counterparts. This made the demand lower due to uncertainty of quality.

There may be a few reasons for this disparity. Firstly, purchasing power is lower in rural areas due to lower average income. Thus, even though people prefer quality products over price, they lack money to purchase the products. Another reason as mentioned in a blog, is that there are two major channels through which people in rural areas acquire these technologies. First is through donations from NGOs. These organizations can only provide limited number of products because their funding source is donation, which makes for an unreliable source of income. Second is through manufacturer's own distribution network (Hue, D. & Stenson, J., 2012). This makes it tough for them to juggle their time between sales and production, which again fails to serve the purpose. This makes it tough for companies to understand the priority and eventually, due to ease of logistics and for safety, they go with cheaper products. Combined, these factors lead to customer dissatisfaction. This calls the need for a newer method to bring higher quality products at an affordable price to rural areas.

IV. RECOMMENDATIONS

From the above findings, it is evident that there is lack of a targeted distribution system. Though there are some efforts from NGOs and manufacturers, products aren't reaching the rural markets in the manner or numbers with which they should. There can be three major steps that can be taken for this.

A. Establishment of local rural distribution networks

The main problem for accessibility of the products was poor logistics and inefficient rural networks. Companies were hesitant to launch their products in rural areas due to scattered markets and lower income. This can be solved by setting up local distribution networks. Local population needs to be trained in sales and marketing of renewable energy products. This can be achieved by targeting groups such as unemployed diploma graduates and women self-help groups (SHGs). Among the NGOs surveyed, a few of them covered upto 250 SHGs which were employed in various small occupations. Training them in sales of these products could help promote awareness for renewable energy products and also provide an employment opportunity for them. The contacted companies expressed their interest in starting such a business and providing anywhere from 20 to 45 percent commission for each of their products. A large scale implementation of this project could prove to be a major revenue generating activity for women in rural areas.

B. Servicing and warranty

Another major reason because of which people are hesitant to purchase these products in rural areas is due to lack of servicing centers. Because of scattered population, it is not economically viable for manufacturers to establish a full-fledged

servicing center in one location. This can be solved by servicing training by manufacturers themselves. The companies providing products for distribution could conduct a training class for a selective group, preferably unemployed youth and women self-help groups, thus empowering them to be independent in sales as well as maintenance of the products. The contacted companies voiced their interest in this idea because it was profitable for them in the long run. The companies suggested they can send one service executive for a training program lasting about 3 days. The service executive would conduct training classes on the basic specification of the product and on servicing the product. Right after this class, the trained group can start establishing their distribution and retail centers.

C. Financing

The companies and the NGOs displayed a varied interest on the actual requirement. While the companies suggested that people would give priority to price over quality, the NGOs stated that a majority of the population did not mind paying a higher price for guaranteed quality improvement. But this demand is not supplemented by the lower per capita income in rural areas. This calls for alternate funding options. For starting the distribution networks, people needed short term loans with a minimal interest such as a bank overdrafts. Minority groups such as a self-help group or a joint liability group has a higher chance of acquiring a loan by utilizing selective bank schemes allocated for entrepreneurial group. Also, a group provided more safety for the bank to provide loans. This allowed the distributors to obtain very short term loans with no collateral. The distributors could use this amount to make purchase orders from the manufacturers and pay back right when the customer purchases the product. Instead of a physical shop, the group could utilize a digital catalog or ecommerce in order to reduce the starting capital. The distributors could act as a direct connection between the company and the consumer. Digital transactions and online connectivity can be a good alternative to traditional marketing considering the advancement of internet connectivity and mobile telephony in India right now.

D. Research

Apart from manufacturers, there needs to be a common portals for innovators to submit their ideas and get it into manufacturing stage. The best possibility for this is a virtual research consortium. Thousands of projects are developed in academia each year which never see the light of day. A collaboration between universities could help promote these products. A certain number of research areas could be proposed to universities for their students to take up. After completion of their undergraduate, the students have the chance to get their products commercialized for utilization in rural India.

Establishment of a common portal for linkage between academia, industry and rural markets and a dedicated virtual research center could help in solving the awareness, accessibility and pricing problems in rural India.

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