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Adoption of Renewable Energy Technologies by Rural Population: Impact on Quality of Life

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Abstract—*The energy problems of the developing countries are both serious and widespread. Lack of access to sufficient and sustainable supplies of energy affects as much as 90% of the population of many developing countries. about two billion people are without electricity; a similar number remain dependent on fuels such as animal dung, crop residues, wood, and charcoal to cook their daily meals. Without efficient, clean energy, people are undermined in their efforts to engage effectively in productive activities or to improve their quality of life. Developing countries are facing two-pronged crisisin the energy sector. The first is the widespread inefficient production and use of traditional energy sources, such as fuel wood and agricultural residues, which pose economic, environmental, and health hazards. The second is the highly uneven distribution and use of modern energy sources, such as electricity, petroleum products, and liquefied or compressed natural gas, which pose important issues of economics, equity, and quality of life. With the change in rural scenario, agricultural practices, advent of gadgets, i.e, television, mobile phones, computers, etc. the demand of energy has increased manifolds.*

Growing demand of energy has necessitated the need for finding alternative energy resources for meeting the growing demand in urban as well as rural areas. This paper attempts to understand the user perspectives to bring about change in their quality of life by the use of Renewable Energy Technologies. The findings of the research bring forth the gaps in technology transfer.

Keywords: *Renewable Energy Technologies, Quality of Life, Rural Energy Programs.*

1. INTRODUCTION

Energy security measures for Rural Areas

All societies require energy services to meet basic human needs (e.g., lighting, cooking, space comfort, mobility, communication) and to serve productive processes. The quality of energy is important for the development of communities (Cleveland et al., 1984; Brookes, 2000; Kaufmann, 2004).

For development to be sustainable, delivery of energy services needs to be secure and have low environmental impacts. Renewable Energy (RE) sources play an important role in maintaining sustainability in provision of energy services and, in particular, mitigating climate change. Besides a variety of renewable energy resources deployed all over the country, which help in meeting the growing energy requirement for the domestic, agricultural, commercial and industrial sectors in rural and urban areas. Ministry of New and Renewable Energy (MNRE) is promoting the renewable energy application in rural areas through fiscal and financial incentives including concessional interest-based loans. Rural population prefers to use locally available resources for fuel, etc. as they are within their vicinity and available free of cost. Due to such a practice there is depletion of natural resources which is leading to ecological issues of concern. There are several reasons why rural energy deserves special attention distinct from energy in general. First and foremost, if rural energy is not treated separately, it is bound to be deprived of appropriate and deserved emphasis because it 'would fall between the cracks'. Second, the demography of rural areas differs fundamentally from that of urban towns, cities and metropolises. Rural areas consist of dispersed populations in contrast to the population concentrations of urban conglomerations. This fundamental distinction leads to a third reason for treating rural energy differently. Centralized generation of energy may be a feasible option for urban areas but not for rural as it may be costly and inefficient for the dispersed population in areas that are remote, scattered and require low loads leading inevitably to greater transmission and distribution losses. Beyond certain break-even distances from the grids/transport systems associated with centralized generation, it may be more cost-effective to implement decentralized village-scale generation coupled with mini-grids. The development of various renewable energy systems began as early as in 1953. In 1981, the Government of India established a Commission for Additional Sources of Energy (CASE) in the Department of Science and Technology, on the lines of the Space and Atomic Commissions. In 1982, a new department, i.e, Department of Non-conventional Energy Sources (DNES), that incorporated CASE, was created in the then Ministry of Energy. In 1992, DNES became the Ministry of Non-conventional Energy

Sources. In October 2006, the Ministry was rechristened as Ministry of New and Renewable Energy (MNRE). India is the only country in the world with an exclusive Ministry to deal with this sector.

2. METHODOLOGY

The present research is ongoing and has two main focuses. First, the effect of Government initiatives for implementing use and adoption of solar energy technologies for rural population under its various programs. this has been investigated through a survey conducted on rural residents living in remote villages electrified by State Nodal Agencies (SNAs) , service engineers, local engineers and *panchayat* members. Second the repair and maintenance of RETs have been investigated through interview and observations of households, service engineers of the State Nodal Agency, HAREDA as well as with operators (in *akshay urja* shops) in the selected rural areas.

3. RESULTS AND DISCUSSIONS

3.1 Rural Energy practices

All the households selected for the study were situated in the hilly terrain and the primary occupation of the rural residents was agriculture. Villages/hamlets were selected on the basis of usage of solar energy technologies. The study revealed that all the households in the selected villages/hamlets in Haryana were found to be using one or more solar energy technologies. The systems found in the households included lighting systems, i.e, solar lanterns, solar home lighting systems (LED and CFL module), solar torch and solar street lights. Solar torch was more prevalent in Haryana while solar street lights were used at the community level. Solar water heaters were very popular among the rural as well as urban areas of Haryana. Interestingly in Panchkula district, Haryana, many rural households, connected to the conventional grid were using more than one solar lighting devices including solar lantern, solar torch and solar home lighting system. Apart from this solar cookers (box type and parabolic type) were in use among a few households. The reason for the popularity was ease and comfort in using RE devices particularly during long duration of power cuts in the selected villages wherein the residents had to depend on RETses. The residents, infact informed that for only a few hours, power was available otherwise most of the time there was power cut. Therefore their dependence on RETs was overwhelming. Apart from lack of conventional options of energy, most residents had inhibitions for adopting RETs, such as, high initial investment, inadequate knowledge for use and operation, poor repair and maintenance facilities, etc.

Awareness about Renewable Energy Technologies In Haryana, *Akshay Urja* Shops were the key source of awareness (42%) followed by solar fairs which accounted to 22%. One of the reasons as observed during the research was the presence and involvement of State Nodal Agency (SNA) personnel in the community. As informed by the residents, the personnel visit the community, as and when there were complaints. The occasional delays are mainly due to the lack of trained personnel in the hilly terrain. The residents appreciate and respect the efforts taken by the Haryana Renewable Energy Development Agency. Electronic media and non-government organizations had very less presence and awareness recall, i.e, 8%. Table 1 below shows the breakup of the sources of awareness for RETs in rural households of Haryana.

Table 1: Sources of Awareness about RETs

Sources of RETs related Information	Haryana
Solar Fair	26%
Print media	22%
Electronic media	7%
***Akshay Urja* shops**	45%
NGO	1%

The awareness regarding various aspects of renewable energy revealed that the awareness towards RETs were more with male respondents as compared to the female members in the rural areas. In village 2 despite of the fact that females were actively involved in the household chores using various energy resources for different activities of the house ranging from cooking food for the family, taking care of animals, working in the fields, child care, procuring fuel and collecting fodder for animals etc. were less aware (21%) as they felt that men (54%) kept abreast with the technical aspects of RETs relating to installation, repair and maintenance.

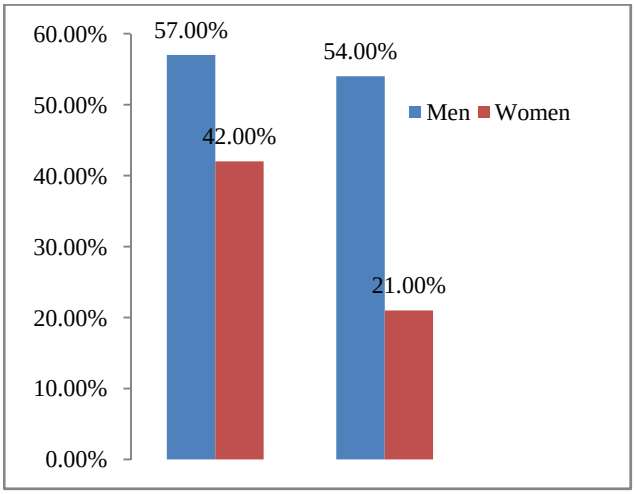

Fig. 1: Awareness comparison about RETs between of men and women of rural households in Haryana

Though in village 1 since men were usually employed in the urban areas and were out for work for long duration of time,

the households were looked after by the female members. This could possibly be the reason for better awareness among women members regarding RETs (42%) as compared to women in village 1. The Fig. 1 shows the awareness comparison of men and women of two selected villages in Haryana state.

Training programs designed by MNRE and implemented by State Nodal Agencies also trained local technicians to open up shops and become entrepreneurs. Rural areas covered in the study had universal need of trained personnel in the area. Solar Fairs and Electronic media shared the same percentage of effectiveness in creating awareness in the selected villages. The typical frequency of a workshop is once in a quarter. These workshops targeted both potential and existing users of RE equipment.

3.2 Gaps in Technology Transfer

3.2.1 Availability of RETs

With time availability of RET products is increasing in Haryana. This can be attributed to the increasing efforts to promote renewable energy equipment in the respective areas. The residents of both the villages were satisfied with the availability of RE devices at the *Akshay Urja* Shops which were 15-20 kms away from the village and took approximately half to one hour to reach. RETs ranging from solar cooker (box and parabolic type), solar lanterns, solar home lighting systems (LED and CFL), and solar torch were readily available at the solar shops.

3.2.2 Availability of training, repair and renovation services in RETs

The repair and maintenance contract for the power plants that were used in few villages at higher altitudes in Panchkula was usually for 5 years. For people who have not seen light since ages solar energy has been a ray of hope and has changed lives for good. The service personnel usually employed by the State Nodal Agency, HAREDA in Haryana were trained and capable of solving the problems. The response time is usually one to two days. In the hilly terrain though, due to weather conditions and difficult topography sometimes delay was there. Need for more repair and maintenance shops and more trained engineers was observed by the research team as well as reported by the residents.

3.2.3 Challenges in use and operation

The workshops for training are very important for usage and operation of RETs. However, these training workshops were only attended by the selected family members of the villages. This limits the knowledge of usage to selective members. Lack of operational and maintenance knowledge usually results in improper usage of equipment. This in-turn decreases the life and productivity of the equipment. In many cases we observed that solar battery was not maintained properly resulting in lower life of the same. Another example of challenge is know-how to operate solar cookers. This results in not optimal usage of cooker; hence the complete utilization is prevented. This also causes the dis-satisfaction from RETs.

Broken and stolen panels imposed a huge problem in ensuring success of the rural electrification programs. The other reasons were quality of components and installation, and inverter failure which was indeed reported to be a big problem by the residents.

4. IMPLICATIONS OF RE DEVICES FOR RURAL RESIDENTS: CHANGE IN QUALITY OF LIFE

Energy is mainly required for cooking, heating, lighting, motive power, irrigation, small cottage industry, agricultural operations, drying, etc. in rural areas of Haryana. Renewable energy played a vital role in meeting the energy demands for the end use applications. Over the last three decades many renewable energy systems and devices such as biogas plants, photovoltaic systems, biomass gasifiers, and solar cookers besides, other solar thermal systems have been developed and have proved to be very useful for the residents. The results of the study have shown ***extended working day*** in the rural areas of Haryana. On average it is dark by 6:30 year round. Solar Lighting allows rural families to extend their workday into the evening hours. Many villages where solar lights are installed see an increase in their economic activity levels. Installing solar lights in villages allows businesses to operate during the evening. Solar electricity helps ***promote local enterprises*** as small shops and village markets can use the systems to provide lighting to operate during the evening. Almost all the families using solar lanterns are benefitting from solar street lights felt that ***safety in and around the house*** have increased because of solar lighting. Some of the common responses for benefits in safety included: ***no*** *risk of fire from kerosene lanterns; reduced threat of bear attack; reduced chance of snake bite; safety in use of toilets at night; reduced fear of ghosts among younger children*. The study has by far revealed that there has been *increase in study time* by students with the introduction of Solar Home Lighting Systems, Solar Lanterns and Solar Street Lights in the villages. For villages electrified in the past two years, children's daily study habits at home were stated to have increased by on average 41 min (N=61) from 35 min before, and thus, resulting in acceptance towards renewable energy and related technologies. As far as the *cooking time* is concerned the study shows that the commencement time was stated as on average 25 min earlier for SHS households before electrification, but no different after electrification. *Monthly household kerosene use was found to decrease* by 2.04, from 3.0 (N=100) to 1.0 l (N=100) after electrification. At 15 INR, the average savings on kerosene for each household is more than 30 INR per month. The usage before electrification was on average 0.4 5 higher for SHS than for micro-grid households, but no different after

electrification. SHSs are installed in smaller villages and hamlets with larger distances between houses, and this may account for the differences. The incidences of health issues related to breathing and eye ailments were reported to have decreased with the use of solar lanterns and home lighting systems. Since, the fumes from kerosene lamps in poorly ventilated houses are a serious health problem in much of the world where electric light is unavailable. The World Bank estimates that 780 million women and children breathing kerosene fumes inhale the equivalent of smoke from 2 packs of cigarettes a day. By the use of Solar Lanterns these issues are resolved.

5. CONCLUSION

First, the good news is that the price of solar energy has come crashing down in the past two-three years. The first bad news is that there is no money to pay for the second phase of solar power development. In the first phase of the national solar mission, one unit of expensive and clean solar power was bundled with four units of cheaper and dirtier coal power to pay for the price difference. Second bad news is that 90 per cent of domestic solar manufacturing has closed or filed for debt restructuring. Solar imports have flooded the market. This is when the stated aim of the national solar mission was to encourage domestic manufacturing. As a result, imported thin film technology, which is not so durable and efficient, today dominates the Indian solar industry. The third bad news in the solar sector development is of even more fundamental nature. The fact is that grid-based solar power continues to reach only those households that are connected to energy supply. In fact, what it does is to subsidies expensive solar for the already-reached population. In a situation where the transmission and distribution losses are 20-25 per cent, it also means that all power generated by solar plants is “lost”. These plants work at a maximum of 20 per cent capacity. **(Narain, 2013)**

Hence, the programs that are aimed at the deployment of RETs in rural areas should be integrated into wider rural development programs to ensure better adoption, effectiveness and sustainability of renewable energy technologies for rural development. It is essential to stimulate uptake of RETs in rural areas, both on the supply and demand sides. Government support may take many forms: regulation, subsidization, import duties, public awareness campaigns, or more likely a combination of these. In order to mitigate against a dependency on donor funds, donor support must be closely in line with government policy and phase-out plans need to be clearly articulated. Mechanisms such as the CDM have potential to promote RETs in rural areas, especially if numerous small projects are bundled together. In order to leave a sustainable local market for RETs after subsidies and donor support is phased out, it is imperative that local supply and demand are developed and fully connected with each other. While regulation can play a role here, especially in maintaining quality control and managing competition, it should be carefully targeted so that it does not prevent sustainable markets for RETs from being established. Opportunities for knowledge sharing, innovation and learning by suppliers and users can also help to improve products and reduce costs. Deployment of RETs requires hardware and “software” elements. Adequate training in areas such as installation, operation and maintenance – as well as learning and awareness- raising activities - are key to developing the local knowledge required for effective and sustainable RET use. If rural development through the use of RETs is to be sustainable and low-carbon, it is essential to build local capacity among both technology suppliers and users.

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