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Renewable Energy and Rural Environment in India: Challenges Ahead

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Abstract. In order to fulfill the goal of 'Power for all by 2012' the Ministry of New and Renewable Energy (MNRE) has been implementing the 'Remote Village Electrification Programme (RVEP)' to electrify all unelectrified census villages and hamlets by installing solar photovoltaic (PV) home lighting systems. Under the programme, the Ministry provides up to 90 per cent of the cost of the systems as subsidy to the state implementing agencies and 10 per cent of the cost is provided by the state government. The programme is being implemented in all the states. An evaluation study was carried out by National Council of Applied Economic Research (NCAER) in six most difficult states, viz Assam, Meghalaya, Jharkhand, Odisha, Madhya Pradesh and Chhattisgarh in India [1, 2].

In this paper an attempt is made to assess (a) the functionality of the solar PV systems provided to the households and (b) social impact of the programme among the beneficiaries in all these six states. During rainy seasons 50 to 99 per cent of beneficiaries reported of having light for less than three hours. During winter 34 to 79 per cent reported of having light for more than four hours whereas during summer 79 to 91 per cent reported of having light for more than four hours a day.

Keywords: Renewable energy, Rural electrification, Environment, Challenges

1. Introduction

Rural electrification is defined as the supply of electricity to small towns and villages, and agro-based industries outside the regional capitals to bring about important social and economic benefits [3, 4]. Rural electrification supply can be achieved by using the national grid, mini-grid, isolated generator systems or renewable energy including solar photovoltaics, wind power plants, small hydropower and bio-fuel engines, among others.

Rural electrification was not considered as a basic human need like water and food in the past. Recent studies have emphasised the importance of electrification for meeting basic needs such as health, agriculture, education, information and other infrastructural services. There is a clear correlation between per capita income and human development index [5, 6]. Although rural electrification does not reduce poverty directly, its relationship to poverty reduction cannot be denied [4]. Several research studies have provided analysis of the link between electricity and major global issues such as health, education, water, gender, etc. [7, 8]. All these studies conclude that though electricity alone cannot initiate development and reduce poverty; it must be linked to development strategies for education, health, agriculture and infrastructure, and to political and economic improvements.

The extent of electricity consumption of a country is one of the indicators of its socio-economic development. Per capita electricity consumption in India is the lowest in the world (Table 1).

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Table 1: Per capita electricity consumption by different countries (2008)

Countries	USA	France	UK	Russia	Brazil	China	India
KWh/Per capita	13654	7695	6062	6435	2237	2455	566

Source: [9]

India's per capita electricity consumption is as low as 4.15 per cent of that of USA. In India about 579 million people, that is 35 per cent of world's population, is living without access to electricity.

On March 3, 2001, the Prime Minister of India convened a meeting of all the Chief Ministers of states to build a national consensus, where rural electrification got the top-most priority. Important resolutions included in the consensus are (a) electrification of all villages and households is to be undertaken; rural electrification is to be treated as a basic minimum service, (b) rural electrification is to be completed by 2007, and electrification of all households by 2012.

2. Methodology

Household surveys were carried out by NCAER in 2008 and 2010 to collect information from about 10,000 households from 371 villages spread over 41 districts in Assam, Meghalaya, Jharkhand, Odisha, Madhya Pradesh and Chhattisgarh. Two well-structured questionnaires were developed. One was canvassed at village level and the other at beneficiary household level to assess the functionality of the systems, the pattern of their installation and the impact of the programme. Focus Group Discussions (FGDs) were also held to assess the impact of the programme in rural beneficiary households in selected villages.

2.1. Technical Issues with SPV Home Lighting System

Several technical issues, such as those listed below, need to be taken care of while installing the systems.

- If the system is not installed properly it would work inefficiently and the output could be reduced.
- As far as possible, the module should face the south and inclined at an optimum angle. It should be firmly fixed on the ground or on the roof.
- The lamp should be positioned in a such a manner that it gives the maximum utility of light.
- The street lighting systems should be positioned in such a manner that light should be focused on the ground.
- The system is designed for a particular type of lamp. Whenever lamps are replaced, as far as possible the same type of the lamp should be used again as otherwise the output may not be optimum.

3. Survey Results

Proper functionality of the system is determined by many factors. These are (a) capacity of module (b) installation of module (c) fixation of luminaires inside the house and (d) fixing of cable and so on. If the module is installed properly, fixation of luminaires is proper, and fixing of cable from charge controller to module is also proper, then one CFL can provide light up to 10 hours a day in normal weather conditions.Two CFLs can provide light up to four to five hours a day. One of the major advantages of solar home lighting system is that energy can be stored in the battery for two to three days, if the lights are used scarcely. In the present study, an assessment has been carried out to check the duration of availability of light to the beneficiaries during different seasons.

3.1. Functionality of the System in Rainy Season

During rainy season about 99 per cent of the beneficiaries in Meghalaya reported receipt of light for less than three hours, whereas 45.5 per cent beneficiaries in Chhattisgarh reported receiving light for less than three hours (Table 2). About 38 per cent of beneficiaries reported receipt of light for three to four hours in the rainy season in Odisha. The functionality of the system seems to be better in Chhattisgarh as 32 per cent of beneficiaries reported having lights for four to five hours during the rainy season. However, majority of the beneficiaries reported receipt of light for less than three hours.

Table 2: Average duration the luminaires work per day during rainy season (per cent responses)

States\No. of hrs	> 3 hrs	3–4 hrs	4–5 hrs	< 5 hrs	Total	Average work duration (hrs)
Meghalaya	99.0	0.0	0.0	1.0	100	2.0
Jharkhand	70.9	27.6	1.3	0.1	100	2.5
Assam	65.3	32.9	1.0	0.8	100	2.5
Odisha	50.4	38.4	10.3	1.0	100	3.1
Madhya Pradesh	73.3	25.4	1.4	0.0	100	2.8
Chhattisgarh	45.5	22.6	31.8	0.1	100	3.4

Sources: [1, 2]

3.2. Functionality of the System in Winter Season

During winter season the functionality of the luminaires looks moderate as only 2 to 14 per cent reported getting light less than three hours in Assam and Jharkhand. About 53 per cent of the beneficiaries in Madhya Pradesh reported receipt of light between three to four hours per day in winter, whereas only 20 per cent reported receipt of light between three to four hours in Assam and Meghalaya (Table 3). Except Madhya Pradesh, majority of the beneficiaries reported receipt of light for more than four hours in winter season.

Table 3: Average duration the luminaires work per day during winter season (per cent responses)

States\No. of hrs	> 3 hrs	3–4 hrs	4–5 hrs	< 5 hrs	Total	Average work duration
Meghalaya	0.0	20.5	60.5	18.9	100	4.4
Jharkhand	14.1	31.0	46.2	8.7	100	3.9
Assam	1.6	20.2	39.4	38.8	100	4.5
Odisha	4.6	40.9	38.4	16.2	100	4.2
Madhya Pradesh	12.9	53.0	33.3	0.8	100	3.7
Chhattisgarh	0.4	39.1	28.3	32.2	100	4.4

Sources: [1, 2]

3.3. Functionality of the System in Summer Season

The functionality of the system seems to be very satisfactory in summer as 29 to 61 per cent of beneficiaries reported getting light for four to five hours in Jharkhand and Meghalaya. The receipt of light for more than five hours a day during summer was reported by 23 to 63 per cent of beneficiaries in Meghalaya and Jharkhand (Table 4).

Table 4: Average duration the luminaires work per day: during winter season (perent responses)

States\No. of hrs	> 3 hrs	3–4 hrs	4–5 hrs	< 5 hrs	Total	Average work duration
Meghalaya	0.0	16.2	60.5	23.2	100	4.5
Jharkhand	2.1	6.6	28.7	62.6	100	4.7
Assam	4.7	20.8	33.9	40.7	100	4.4
Odisha	2.6	19.7	38.6	39.2	100	4.6
Madhya Pradesh	1.7	11.0	45.3	42.1	100	4.8
Chhattisgarh	0.1	21.0	36.8	42.1	100	4.7

Sources: [1, 2]

4. Impact Evaluation

Impact of the programme may be assessed from the substantial reduction in the monthly expenditure on lighting after installation of solar home lighting systems in all the sample states (Table 5). The beneficiary households have continued to use kerosene for other purposes than lighting the room after the installation of solar PV systems in the households, but in smaller quantity. The expenditure on lighting has reduced by more than half in Meghalaya, Assam and Jharkhand. The reduction of expediture on lighting is relatively less in Madhya Pradesh, Odisha and Chhattisgarh.

Table 5: Monthly expenditure on lighting before and after SPVs were installed per month (` per month)

Status	Meghalaya	Assam	Jharkhand	Madhya Pradesh	Odisha	Chhattisgarh
Before SPV	145	120	72	57	35	24
After SPV	60	50	29	33	29	23

Sources: [1, 2]

4.1. Impact on Daily Lives

Multiple activities take place in the beneficiary households during the time when electricity is available in the evening. These are cooking, teaching children and studying, recreation and other household activities. We also asked them to indicate the most important activity on which the maximum time was used when the light is available at home. About 58 per cent indicated teaching children and studying in Jharkhand, whereas 60 and 45 per cent of beneficiaries have indicated the same in Assam and Meghalaya, respectively [1, 2]. This finding is further supported as 64, 69 and 53 per cent of beneficiaries from Jharkhand, Assam and Meghalaya, respectively, reported that there is significant improvement in their children's education. Similarly, 28, 52 and 34 per cent of beneficiaries from Odisha, Madhya Pradesh and Chhattisgarh, respectively, reported that there is significant improvement in their children's education. About 52, 55, 37, 42, 78 and 48 per cent beneficiaries from Jharkhand, Assam, Meghalaya, Odisha, Madhya Pradesh and Chhattisgarh, respectively, reported minor improvement in the standard of living after installation of solar lighting systems in their households.

5. Conclusion

The present study shows that solar home lighting systems in remote villages can influence the life of the people very significantly for the better. Multiple benefits have been realised by the beneficiary households from solar home lighting systems. Substantial reduction in expenditure on kerosene has been found in all income groups' households due to solar home lighting systems. *This scheme mostly benefits women and children. Women find it easy to do household activities whereas children get enough light to study at night.* Crime rate has also been declining due to availability of light in the village. Most of the beneficiaries of solar home lighting systems are very happy with the system.

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