



Rural Electrification through Solar Energy: Insights from Chattisgarh State of India

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Abstract. The Indian energy sector has witnessed a rapid growth in an effort to meet the demands of a developing nation. However, continued use of fossil fuels is set to face multiple challenges: depletion of fossil fuel reserves, global warming and other environmental concerns, geopolitical and military conflicts and of late, continued and a significant increase in fuel price. Renewable energy is the solution to the growing energy challenges as they are abundant, inexhaustible and environmentally friendly. Accelerating the use of renewable energy, specifically solar energy, is also indispensable if India is to meet its commitments to reduce its carbon intensity. Given the vast potential of solar energy in India, all that India needs is put comprehensive policies in place to be a global leader in sustainable and green energy. The Government has taken a number of steps towards improving the adoption of solar energy on a large scale in the country. Many programs and policies have been initiated at both the National and State levels to promote solar energy, but its use and production in the country is still limited. On studying one of the major initiatives of the National government, the "Remote Rural Village Electrification" in Chhattisgarh as a case, it was found that there was a gap between the policies and the actual scenario. The awareness level among the beneficiaries was found to be very low. Thus, there is an urgent need to create awareness among the stakeholders regarding the government initiatives, so that solar energy is widely accepted and used.

Keywords. Awareness, Government Policies, Rural Electrification, Solar Energy

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1. Introduction

Energy is the prime mover of economic growth and is vital to sustaining a modern economy and society. Future economic growth significantly depends on the long-term availability affordable, accessible and secure sources of energy. Although 80% of the world's population lies in the developing countries (a fourfold population increase in the past 25 years), their energy consumption amounts to only 40% of the world's total energy consumption. The high standards of living in the developed countries are attributable to high-energy consumption levels. In industrialized countries, people use four to five times more than the world average and nine times more than the average for the developing countries (Bureau of Energy Efficiency [BEE], 2009). Energy use is

inevitable for human life and a secure and accessible supply of energy is crucial for the sustainability of modern societies (Asif and Muneer, 2007). Energy has been recognized as one of the most pertinent contributors of economic growth and human development universally. There is a strong two-way relationship between economic development and energy consumption. On one hand, the growth of an economy hinges on the availability of cost-effective and environmentally benign energy sources, and on the other hand, the level of economic development relies on the energy demand (India Energy Portal, n.d.). Today, India can well be identified as an energy guzzler. The demand for power in India is growing exponentially and the scope of growth of this

sector is immense. In an effort to meet the demands of a developing nation, the Indian energy sector has witnessed a rapid growth (Ministry of New and Renewable Energy [MNRE], 2011a).

The electricity consumption per capita in India is just 566 KWh, which is far below most other countries or regions in the world. Although 85% of villages are considered electrified, around 57% of the rural households and 12% of urban households, i.e. 84 million households in the country, do not have access to electricity. Electricity consumption in India is expected to rise to around 2280 kWh by 2021-22 and around 4500 kWh by 2031-32 (Garg, 2012). India is heavily dependent on fossil fuels for most of its demand. It is evident by the fact that coal accounts for almost 55% of the country's total energy supplies and about 75% of the coal in the country is consumed in the power sector. Coal is followed by crude oil and natural gas in terms of usage in the power sector (India Energy Portal, n.d.). Continued use of fossil fuels is set to face multiple challenges: depletion of fossil fuel reserves, global warming and other environmental concerns, geopolitical and military conflicts and of late, continued and a significant increase in fuel price. Renewable energy is the solution to the growing energy challenges as they are abundant, inexhaustible and environmentally friendly (Asif and Muneer, 2006).

Accelerating the use of renewable energy is also indispensable if India is to meet its commitments to reduce its carbon intensity. The power sector contributes nearly half of the country's carbon emissions. On average, every 1GW of additional renewable energy reduces CO₂ emissions by 3.3 million tons a year. Investing in renewable energy would enable India to develop globally competitive industries and technologies that can provide new opportunities for growth and leadership (Sargsyan et al., 2010). As per the Ministry of New and Renewable Energy, India is the 4th largest country with regard to installing power generation capacity in the field of renewable energy. The Wind, hydro, biomass and solar are the main renewable energy sources in India. The country has an estimated renewable energy potential of around 85,000 MW from commercially exploitable sources (MNRE, 2011b). Currently, India has an installed base of over 27,000 MW of

renewable energy, which is around 17% of India's total power generation capacity (Abdullah, 2011).

If we try to look at all the renewable energy sources, it is seen that India is among the top 5 destinations for solar energy development in the world as per Ernst & Young's renewable energy attractiveness index (MNRE, 2011c). Because of its location between the Tropic of Cancer and the Equator, India has an average annual temperature that ranges from 25°C to 27.5 °C. This means that India has a huge solar potential (Meisen, 2006). Most parts of India have 300 - 330 sunny days in a year, which is equivalent to over 5000 trillion kWh per year— more than India's total energy consumption per year. India is expected to have installed solar energy capacity of 20,000 MW by 2022 (MNRE, 2011d). Thus, if we look at the renewable energy potential, solar energy provides a great opportunity for India to have a sustainable energy scenario. Hence, it is important to understand the initiatives taken by the Indian Government to promote renewable sources of energy, with specific reference to solar energy.

Review of extant literature has shown that there are many programs and policies that have been initiated by the Indian government, both at the National and the State level for promoting renewable energy. However, production and use of renewable energy in the country is still limited. It is important to understand the programs, policies and incentives started by the Government in detail. Further, there is a need to understand the awareness and satisfaction level of the end users, who are the beneficiaries of these renewable (solar) energy projects. The study also envisages to understand the impediments to implementing these initiatives from the perspective of the Government and generate a framework for better acceptance and implementation of such programs and policies. The literature review showed that even though information on the policies, programs and incentives are available, the stakeholders' perspective is yet to be studied. The present paper focuses on the impediments associated with solar energy policies from the stakeholders' perspective.

2. Methodology

The study was conducted in the state of Chhattisgarh in India, which is situated in Central India. Urban Chhattisgarh is one of the few Indian states where the power sector is effectively developed. The Chhattisgarh State Electricity Board (CSEB) is in a strong position to meet the electricity requirements of the new state and is in good financial health. Talking about the rural areas of the state, deciduous forests of the Eastern Highlands Forests cover roughly 44% of the state, and for this reason, these areas are yet to receive grid-connected power. Thus, non-conventional energy sources have been accorded very high priority. To cater to this issue, a special agency called Chhattisgarh Renewable Energy Development Agency (CREDA) has been set up, and over 1200 villages in dense forests are being electrified using off-grid energy. CREDA is the nodal agency of the Ministry of New and Renewable Energy. This organization comes under the State Government, but eventually implements the policies brought out by the Central Government.

Four villages, namely Kobahara, Rawan, Mahoda and Latadadar were selected in this study. All of them were electrified by solar energy under the Remote Village Electrification Programme. From

each village, eight households were selected and one respondent from each household was interviewed based on their willingness to take part in the study. The respondents included both men and women. Government officials in CREDA were also interviewed to take their perspective on the catalysts and barriers associated with solar energy policies in the state. The methodology has been summarized in Figure 1.

3. Government Programs and Policies

The Government of India has come out with a number of policies and programs to promote renewable energy, and specifically solar energy, in India. The National Solar Mission is a major initiative of the Government of India and State Governments to promote ecologically sustainable growth while addressing India's energy security challenge. It will also constitute a major contribution by India to the global effort to meet the challenges of climate change. Solar is currently high on absolute costs compared to other sources of power such as coal. The Mission recognizes that there are a number of off-grid solar applications, particularly for meeting rural energy needs, which are already cost-effective and provides for their rapid expansion.

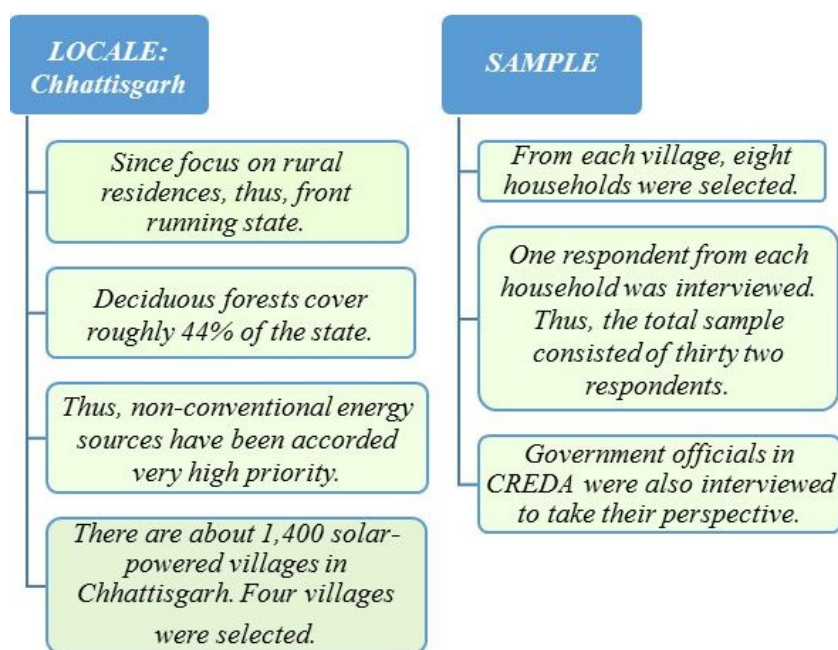


Figure 1: Methodology

It also states that off-grid, decentralized and low-temperature applications will be advantageous from a rural electrification perspective and meeting other energy needs for power, heating and cooling in both rural and urban areas.

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 were (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.

Taking the said missions forward, the National Action Plan on Climate Change was launched in 2008 with eight missions under it, dealing with various issues. Under the National Solar Mission, one of the programs for off-grid power solution is the Remote Village Electrification Program, which was brought out by MNRE. This Ministry is implementing this program by providing financial support for electrification of remote unelectrified census villages and unelectrified hamlets of electrified census villages where grid extension is either not feasible or not cost effective. Such villages are provided basic electricity facilities through various renewable energy sources, particularly solar. The beneficiaries of this scheme are the village households, which get solar power for their basic lighting requirements. Additionally, street lighting systems with 11 W CFL are also considered under the project.

The Ministry provides a subsidy of up to 90% of the costs of the renewable electricity generation systems (including the cost of Annual Maintenance Contract (AMC), if any, for 5 years). The balance cost of projects can be financed through contributions from respective State Government/CSR funds/entrepreneurs' investment/loan/beneficiaries' contribution or other sources other than Government of India fund. However, it will be necessary that at least half of the balance cost is met from State Government's funding (MNRE, 2011a). About 1,400 solar-powered villages in Chhattisgarh, which are not connected to the national grid because they are in a remote

area, have been enjoying the benefits of electrification under Remote Village Electrification Program.

Impediments in Solar Energy Policies

It was seen that most of the beneficiaries were farmers with a low socio-economic status. The electricity being supplied through solar power was basically used for lighting in the households. Under the projects, basic lighting facilities with two light points (around 9W each) and one socket (around 40W) for operating electronic gadgets for each of the willing households in the village were provided (flexibility of points may be allowed within total 58W). Thus, every household is eligible for a maximum of 58Watts unless the house owner himself wants less. The technology for such projects is simple and the source of power abundant, making it the obvious choice for electrification in rural areas. It was reported that the installation costs were borne by the Central and State governments and the beneficiaries had to pay some monthly amount per CFL that they use. However, it was seen that there was a variation in the amount of money being charged from the villagers per CFL per month. Under the project, the households were eligible to get electricity for six hours a day. However, it was reported that the electricity was available for only three to four hours a day.

Most of the respondents said that one of the major barriers in the current solar electricity they were getting was that it was not available during the night when they needed it the most. Some reported that most of the important events such as weddings happen at night, but electricity is not available at that time.

The villagers also reported that the electricity available to each household should be increased, i.e., they wanted to run more appliances such as water pumps, fans, refrigerators and TV sets, not just a single light bulb. Most of the respondents also said that they wanted light for the entire night for their kids to study. Thus, in the short time that the electricity was supplied, the families would start using a lot of appliances like lights, fans, TV etc. and thus, the plant would trip due to overloading, leading to another problem of discontinuous electricity supply. It was disheartening to know that during the four hours

schedule of electricity supply, electricity is effectively available for only half an hour to one hour. During data collection, the researcher also witnessed that the light bulbs kept going on and off.

It was found that although training programs on use and maintenance of solar power plants are regularly organized by CREDA, the end-users were most negligent and thus, lacked awareness. CREDA was involved in training and capacity building of the local people for laying and maintaining the solar power plants. Every village had a plant operator who belonged to that village and was trained by CREDA. However, it was observed that most of the beneficiaries were not aware of solar energy. Although some of them knew that the electricity was coming from the power plant in the village, few knew that the energy source was solar. Many of the respondents were not even aware that there was a power plant in their village. It was surprising to see that even the plant operator's wife was neither aware of the power source, nor the power plant. The maintenance and upkeep of solar power plants were not up to the mark since the beneficiaries are the most negligent. Thus, major problems such as theft of PV panels, overloading etc. were present.

It was seen that cost is the biggest impediment to implementing solar energy policies. Since the Government is trying to increase the capacity of solar power plants in each village, huge investment is required by the Government. It was also found that the Nodal agency of each state has to fight with the Central and State governments for finances. Another barrier that was reported by CREDA officials was limited manpower available in the organization. This resulted in many problems poor associated with training of the local people, maintenance of the power plants and so on.

Thus, all the above came out as the main impediments to solar energy policies' and their implementation which need to be worked upon.

4. Conclusion and Suggestions

Continued use of fossil fuels is set to face multiple challenges: depletion of fossil fuel reserves,

global warming and other environmental concerns, geopolitical and military conflicts, and, of late, continued and significant fuel price rise. Renewable energy is the solution to the growing energy challenges as they are abundant, inexhaustible and environmentally friendly. Thus, the Government, being the main regulatory body in the country, has an important role to play in promoting renewable energy in the country. National Solar Mission was taken as the main policy initiative by the Government, under which attempt was made to understand the impediments associated with the Remote Village Electrification Program in Chhattisgarh.

After conducting the research, many major impediments came out both from the implementers' and the users' perspectives, such as lack of awareness, high costs involved, the discontinuous supply of electricity and limited capacity. It is suggested that solar power projects be developed, taking care of the local needs of the people. The local people ought to be involved at every stage to have a clear understanding of their requirements so that the projects can be tailored to suit their needs.

Another benefit of involving the local people is that when people are involved in something, they feel connected to it and thus, problems like overloading can be taken care of. When the problem of overloading is taken care of, the problem of erratic electricity supply would also be solved. Another major area of concern is monitoring of these solar power plants. Proper monitoring teams need to be made to overcome the problems of thefts and malicious damage. Also, the capacity of the solar power plants needs to be increased so that more appliances can be supported, therefore dealing with the issue of overloading. Another area that needs attention is the amount of time the electricity is supplied. It is suggested that the electricity be supplied for at least twelve hours a day and especially during the nights.

Awareness is a major area that requires immediate attention. Training programs need to be developed in local languages to spread information on the benefits of solar energy and proper use and maintenance of the plants being installed in the villages. Also, the involvement of women is

critical. Women are the main end-users of electricity in the households as they spend most of their time indoors doing most of the household chores. Empowering them would result in the

empowerment of the entire society. Thus, specialized training programs need to be created for women and be delivered from time to time.

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