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# Socio-economic and environmental implications of solar electrification: Experience of rural Odisha<sup>☆</sup>

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## ABSTRACT

Access to environmentally clean and renewable energy is critically linked with sustainable and inclusive development leading to improvement in overall standard of living of people in rural areas. Availability of such energy in remote areas can foster economic activities and create various avenues for livelihood, whereas lack of sufficient and secure energy may constrain economic growth and development. Given that solar electrification has been gaining increasing importance as a source of environmentally clean and economically efficient energy for people living in rural areas, the present paper is an attempt to understand its socio-economic and environmental implications. Analyzing experiences from two villages of the Indian state of Odisha, the paper finds that households' adaptation to solar energy depends on a set of socio-economic, demographic and institutional factors including governments' approach towards rural electrification. It is also found that solar home system has facilitated socio-economic activities and improved standard of living of households, especially of women living in the area. The beneficiary households also perceive that solar electrification has improved environmental standard by reducing household pollution resulting from use of traditional sources of energy such as kerosene, though confirmation in this regard requires further investigation. However, households' adaptation to solar energy and realization of its potential benefits seems to be constrained by non-availability of maintenance and repairing facilities and access to conventional grid electricity under various programmes of the government. In addition to scaling up solar technology, an institutional framework with quality leadership and active participation of NGOs and other community level organization is necessary to link markets and policies effectively and enhance households' inclination towards greater use of this energy.

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## 1. Introduction

Although it has increased over the years, per capita electricity consumption in rural India is still far behind even many of the developing countries<sup>1</sup>. In fact, providing rural electrification using conventional grid electricity is a major challenge due to its limited generation and transmission capacity and less affordability on the part of the users. Besides, sustainability of conventional grid electricity and its adverse impact on environment is also a matter of serious concern. Since a vast majority of rural households in India have no access to conventional grid electricity, providing alternative sources of clean energy is very important for bridging the rural-urban gap and making the development process inclusive and sustainable. Besides, worldwide strategies on climate protection also call for greater use of renewable energy like solar power to reduce emission of greenhouse gases, conserve critical natural resources and contribute to sustainable development<sup>2</sup>. Since climatic conditions of India provide abundant solar radiation during most part of the year and rural India lacks supply of adequate conventional grid electricity, there is huge potential as well as scope for solar electrification in rural areas of the country.

Existing studies show that solar electrification has immense potential to supply clean energy and thereby contribute to poverty alleviation and sustainable socio-economic development, particularly in rural India where a significant portion of population still live without electricity. Access to affordable energy is expected to result in sustainable development and improvement in living standards in rural areas. Availability of energy in these remote areas can foster economic activities and thereby create various avenues for employment opportunities and social development. It is also expected to pave the way for access to other critical resources such as water, food, and health. On the other hand, improvement in health and education and reduction of poverty are constrained by adequate supplies of affordable energy [17]. A number of studies have also shown that solar electrification is financially attractive and environmentally sustainable in lighting houses and running small rural businesses. Thus, energy generated through solar light is considered as environmentally clean as well as economically and socially beneficial for rural households.

However, there are a number of constraints that limit spreading of solar electrification into non-electrified areas of the country. Some of these constraints include lack of markets for solar energy, inadequate access to institutional credit/subsidy for poor families, lack of awareness and confidence on the part of the marginalized consumers, unavailability of efficient service providers, governments' policy towards alternative sources like conventional grid electricity and kerosene. It is observed that installed solar power capacity of India was based entirely on PV technology with approximately 20% of the capacity being used for off-grid applications [45].

All these raise a few interrelated questions: Why is the extent of solar electrification so low in rural India? Is solar electrification

in rural India economically and ecologically viable? If yes, why is extent of solar electrification so low? What are the roles of markets, policies and institutions in this regard? Can better linking of socio-economic and ecological outcomes enhance households' adaptation to solar electrification and its viability? How can markets be developed and appropriate policies and institutions be designed for this purpose?

The present paper is an attempt to understand these issues. In other words, the objective of the present paper is to understand socio-economic and environmental implications and the emerging issues of solar electrification in rural India. The rationale for such an attempt lies not only in bridging the rural-urban energy gaps, but also in exploring water–energy–food nexus that can potentially promote 'environmental conservation, local livelihoods and food security. All these are crucial for making the development process of India inclusive and sustainable in the long run.

In addition to assessing outcomes of various policy initiatives towards solar electrification at all India level and across major states of the country using secondary data, the present paper also makes an attempt to carry out detailed analysis of experiences of two villages of Odisha to supplement the findings. The case study is based mainly on qualitative techniques such as focus group discussion and transect walk to elicit necessary information on socio-economic and environmental outcomes of solar electrification. Besides, interactions with the officials of the NGO working in the area, village level functionaries and beneficiary households have been carried out to identify the constraints to and opportunities for greater solar electrification and reaping its optimum benefits. Case study approach has been followed for detailed understanding of best practices followed by various institutions which can be replicated as successful models in other regions of the country. Necessary secondary data used in the paper are sourced from the local NGO, Alternative for Rural Movement (ARM).

The rationale for such an attempt can be seen in high concentration of tribal communities with severe poverty and underdevelopment and lack of adequate electrification in rural segment of the state. It is expected that findings of the paper would help in designing policies and institutional framework towards greater use of solar technology for facilitating inclusive and sustainable development. In addition, the research outcomes are likely to pave the way for further research on efficient generation, distribution and use of solar energy in rural segments of the country through effective linkages among markets, policies and institutions.

The paper is divided into six sections. While the second section carries out review of literature and highlight the emerging issues to develop conceptual framework for the paper, the present state of solar electrification in India in general and Odisha in particular is provided in the third section. The fourth section of the paper gives profile of the study area. The major findings of the case study are presented and discussed in the fifth section. The sixth as well as the final section summarizes the paper and highlights the emerging issues that require deeper understanding in future research.

## 2. Review of literature

Existing studies have pointed out that 2 billion people in the world, mostly living in rural areas of developing countries have no access to electricity, and around 1 billion more have intermitted

<sup>1</sup> This is very important considering that over 135 countries across the globe have adopted renewable energy deployment targets, with particular focus on wind and solar energy for electricity production [43].

<sup>2</sup> It is increasingly recognized that use of renewable energy and hence less dependence on conventional grid electricity is crucial for conservation of natural resources and protection of environment.

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