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A STUDY ON MAPPING THE SOLAR ENERGY GROWTH IN INDIA: FACTORS CONTRIBUTING AND PROMOTING THE USAGE OF SOLAR ENERGY

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The abundance of solar radiation in India's geophysical position is amazing because the nation accepts enough radiation to meet its whole annual energy requirement. Radiation is frequently used in thermal and photovoltaic (PV) applications. As solar water heating technology is the most widespread permitted application, the nation has readily accepted solar thermal technologies. Aside from specific devices or systems, solar pumps, solar street lights, solar home systems, and solar lanterns, all of which fall under the umbrella of solar PV technologies, could be useful in both urban and rural locations.

This paper tries to examine the key elements influencing and supporting India's increasing use of solar energy. Empirical research has demonstrated that there is a considerable impact on the expansion of solar energy usage from government regulations, local participation, solar energy finances, and climatic circumstances. This study also seeks to uncover a fresh set of independent factors that influence India's expanding solar energy use.

Keywords: Solar Planning, Energy Security, Solar Financing, SDG 7, Solar CBA.

Introduction

Due to India's geographical location, the country receives an abundance of solar radiation that is more than enough to meet its annual energy needs. Additionally, solar buildings, air heating technology, and steam generation are key draws in urban and industrial locations. Aside from specific devices/systems, pumps, street lights, home systems, and lanterns-all of which run on solar power fall within the category of solar PV technology - which is useful in both rural and urban settings.

The manufacture of base silicon mono-crystalline PV cells has advanced so far, however, India has fallen short in global upliftment. India ranks in the top ten globally in solar PV and cell output (Srivastava & Srivastava, 2013).

a. Policies

By 2022, the Indian government intends to install 175 GW of renewable energy capacity, 100 GW of which will be solar energy. The government has put into place several laws and incentives to encourage the growth of solar energy in the nation to accomplish this goal. These include the National Solar Energy Federation of India, the State Rooftop Solar Power Policy, the Solar Park Scheme, the International Solar Alliance (ISA), where India is a founding member, and the Jawaharlal Nehru National Solar Mission (NSEFI). Overall, the Indian government has been aggressively encouraging the development of solar energy in the nation through a variety of policies and programs.

Scholars agree that subsidies and other supports in the form of laws and regulations are essential for promoting the development of renewable energy (RE) projects and consumer demand, particularly solar energy. Coordination between various agencies and institutes, private-public partnerships,

and intergovernmental engagement at the regional, national, and international levels are also essential (Mekhilef et al., 2014). To enhance investment in renewable energy, policy frameworks have always been crucial in cooperative decisions or approaches with linked entities, such as energy planners and international cooperation agencies (Bhattacharya et al., 2016). To identify the needs for various types of government support, Kapoor et al (2014) examined the potential impediments and constraints at the macro and micro levels is crucial. Later, the government can provide more financial and regulatory support to enable and activate additional potential elements that could work in its favor.

b. Local Participation

Local involvement can enhance the usage of solar energy in several ways:

- Participation and ownership by the community in solar projects can boost interest in and support for the technology.
- Involving neighborhood businesses and groups in the design and execution of solar projects can result in the creation of jobs and other positive economic effects for the neighborhood.
- Enabling people and companies to produce their solar electricity can increase energy independence and reduce reliance on conventional utility companies.
- Efforts at outreach and education can raise people's awareness of and appreciation for solar energy's advantages, which will enhance public support for its use.

Further, the review of the literature reveals that certain key sub-factors determine Local Participation. These include:

- energy security concerns,
- environmental awareness,
- commercial viability of RE technology,
- potential for community solar projects, and residential use,
- public perception of solar energy,
- bolstering local networks at the level of organizations and activities, and
- high voltage power lines

Researchers have occasionally emphasized the significance of these individual sub-factors in their previous work when discussing what influences people's participation in the sector. Transitioning to renewable and sustainable energy has been linked, according to (Schoor and Scholtens 2015), to the transformation of neighborhoods and communities. In their research in (Rio de Janeiro, Arentsen and Bellekom 2014) saw new local initiatives for sustainable development. Regional energy communities expressed one form of this growth. According to (Pasqualetti and Brown 2014), social sciences and geography are crucial for comprehending how people interact with one another and the natural world, as well as how the search for energy is affecting the stability of the world's economy and politics.

c. Solar Energy Finance

With citizens getting involved in finance-related projects, the RE sector has seen tremendous growth

in Germany (Yildiz, 2014). Alafia and Pearce evaluated the potential of ABS (solar asset-backed securities) as an inexpensive financing tool (2014). They suggested pertinent policy recommendations to make ABS implementation easier. In their research in Kenya, (Rolffs et al. 2014) evaluated that socio-technical change in developing nations needs the backing of creative funding strategies, including government subsidies. To determine the Levelized-subsidized cost of energy produced by solar PV systems, (Ondraczek et al. 2015) attempted to map the cost of solar PV in a hundred and forty-three countries, keeping in mind – solar resource availability, and financing prices. They concluded that subsidies were required to keep this industry growing. Reliable, resilient, and strong financial and physical security are necessary for renewable energy. Installing solar PV equipment requires a significant financial outlay. Therefore, a properly allocated security system is required by both the government and customers to protect their property.

There is currently a severe lack of security provisions for solar installations in India. Some of these initiatives are still in the experimental phase, which hinders the possibility of sustained investment in the industry. Users will be protected, and investors will be encouraged, through appropriate policies and security measures. Many nations provide interest rate subsidies or production-based payments to encourage solar energy growth. Using and supporting subsidies or capital grants, India was the first country to take the step.

Instead of relying solely on government funding, the market should drive firms. This adjustment will lower the burden of government subsidies while simultaneously increasing funding for the solar energy industry.

Foster-Pedley and (Hertzog 2006) made the case for the development of a financial framework in the renewable energy industry with a comprehensive viewpoint to improve the success of financing RE entrepreneurs. In their 2012 analysis, Wüstenhagen and Menichetti examined the need for significant private investment to boost the share of RE and stop disastrous anthropogenic climate change.

d. Climatic Conditions

Climatic conditions can improve solar energy use by providing ample sunlight and clear skies. Areas with high levels of sunshine and low cloud cover are ideal for solar energy production. Additionally, solar panels perform better in cooler temperatures, so areas with mild climates can also be well-suited for solar energy use.

A clear, sunny day is the best weather scenario for maximum solar panel output. It can function effectively on a day that is not typically warm. The panels can produce their maximum power even on foggy days. In an environment with frequent cloud cover, (Armstrong and Hurle 2010) have suggested the best tilt angle.

The most practical strategy to combat the greenhouse effect, according to (Mishra's 2016) research on consumption patterns of industrial operations, fossil fuels, waste decomposition, and agricultural systems, is the usage of renewable power. (Atalla et al. 2017) created a scale based on a database of heating/cooling weather and an analysis of the actual cost of living that was theoretically supported. (Hernandez et al. 2014) pointed out that the development of RE may call for a combination of environmental messaging because it is a very advantageous alternative.

Methodology

The research approach is based on variables found by a thorough review of the literature. The research model examined the direct association between four independent variables-government policies, local engagement, solar energy financing, and climatic conditions-and the growth of solar energy usage in India. Different secondary data sources were consulted to compile the information for the study. Data were gathered from databases owned by ProQuest and Elsevier. Figure 1 illustrates how the study framework was created using secondary data. A dependent variable is an increase in India's solar energy consumption.

Research Framework

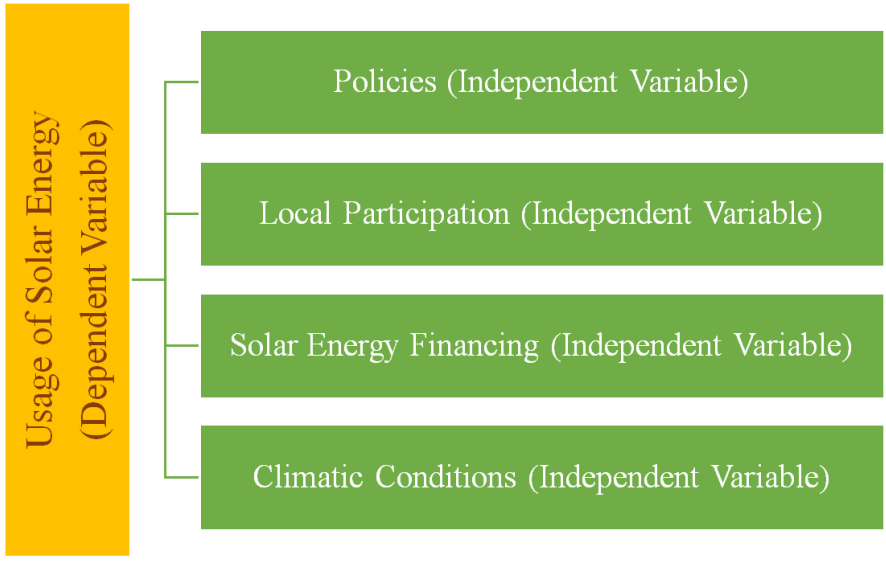

Figure 1: Study Framework for Secondary Data

The study's focus is solely on solar energy expansion use in India. To fill the research gaps a framework has been created as well as previous variables have also been reviewed with their connection to India's increasing use of solar energy.

Research Questions

- Does the rise of solar power usage in India depend on policies?
- How much does local engagement influence the expansion of solar energy use in India?
- Is the availability of solar power financing a significant factor influencing the expansion of solar power use in India?
- Is the climate favorable towards India's shift to solar energy?

Findings

The literature review was structured according to the variables considered in this paper. After gathering scholarly research articles published mostly in Elsevier and ProQuest Direct databases, a substantial number of research papers, articles, and reports published during the past ten years in

India and overseas were reviewed. The increase in India's solar energy consumption is the dependent variable. Policies, local participation, solar energy financing, and climatic conditions are a few of the independent variables.

The following hypothesis was constructed:

H_1: Policies have a significant impact on how much solar energy is used in India.

H_2: Local participation influences significantly solar energy use in India.

H_3: The expansion of solar energy use in India significantly influenced by solar energy financing.

H_4: Climatic conditions have a big role in how much solar energy is used in India.

Table 1: Correlation will be Dependent Variable

Variables	Original Coefficient (β)	Mean Value	Standard Error	t-value	P-value (2-sided)	P-value (1-sided)
Policies	0.265	0.264	0.112	2.364	0.018	0.009
Local Participation	0.196	0.197	0.103	1.894	0.058	0.029
Solar Energy Financing	0.254	0.245	0.124	2.053	0.040	0.020
Climatic Conditions	0.349	0.350	0.093	3.725	0.000	0.000

Findings, Discussions, and Recommendations

- Policies (β = 0.265, t-value = 2.364);
- Local Participation (β = 0.1966, t-value = 1.8944);
- Solar Energy Financing (β = 0.2547, t-value = 2.0537);
- Climatic Conditions (β = 0.3496, t-value = 3.7256)

All the independent variables have a positive significance on the dependent variable i.e., Usage of Solar Energy.

To examine their direct correlations with the dependent variable, four hypotheses were explored.

The most accessible renewable energy source on earth is solar energy. Solar energy solutions enable access to remote and rural areas, supporting long-term energy security and the reduction of greenhouse gas emissions. In terms of the evaluation of grid-connected distributed PV systems and solar hot water systems, solar energy has grown significantly during the last few decades. Utility-scale PV applications with central management have increased substantially in recent years. The study reaffirmed the need for infrastructure facilities to support solar energy, financing, and the ability to build a smart grid system to encourage entrepreneurship in the sector. It also stressed the importance of understanding the content and context of government policies for solar energy.

The government policy is a key independent variable that this study has found to be favorable to the expansion of solar energy usage in India (as research and development are the need of the hour for making cheaper PV cells and other solar equipment). More organizations will adapt their procedures

to the policies as more nations establish their policies about solar energy. Community-based elements, such as people's willingness to join in solar energy initiatives, are virtually supported by actual data. Community participation and engagement are important factors in the successful implementation and adoption of solar energy projects, as it helps to build local support and ownership of the project. Additionally, involving local people in the planning and implementation of solar energy projects can also lead to more sustainable and efficient use of resources, as well as create economic opportunities for the community.

Businesses with the correct policy may have an impact on the growth of solar energy at the local or regional level. Community solar might increase prospective customers to 100% houses (Kalkbrenner & Rosen, 2016). Additionally, (Schoor and Scholtens 2015) have correctly urged the start of additional research to comprehend the connection between people's participation and the expansion of solar energy. Investors in the solar power sector must constantly be exact and concise. The degree of activities and kind of organization within the local network needs to be strengthened. Solar energy conversion into electricity requires a thorough assessment of the environmental analysis. There is a need to close the cost gap between retail solar energy and the current conventional energy production process.

The creation of organic solar cells, which are commercially viable, should be the main priority. Furthermore, filling these gaps would significantly advance knowledge in the field because there has not been much written about the political, economic, and cultural views of solar energy and its market in India.

Finance plays a crucial role in the growth of the solar energy sector in India. The cost of solar technology has decreased in recent years, making it more accessible to a larger population. However, the high cost of initial investment and lack of access to affordable financing options can still be a barrier for many individuals and businesses looking to adopt solar energy. Government incentives, subsidies, and loan programs have helped to make solar energy more financially accessible, and as a result, have led to an increase in the number of solar energy projects in the country. Additionally, the growth of the Green Bonds and Renewable Energy Certificates (RECs) market in India has also helped to make solar energy more financially viable for investors.

To develop the hypothesis, data analysis was done utilizing results from ADANCO 2.0.1.

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