

Revisiting Possible Factors Hindering the Adoption of Solar Energy Products

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Abstract:

To achieve sustainable development and reduce the adverse effect of conventional sources of energy on environment, the adoption of renewable energy is the need of the hour. This review paper re-examines the factors which might hamper the adoption of solar energy products in Indian context by integrating the findings from existing literature. The paper mainly focuses on the factors such as awareness of the product, government initiatives, public readiness and psychographic factors as the factors are recurrently discussed by the researchers. The paper discusses nuances of the factors which can be tamed for accelerating adoption of solar energy in India, especially in relation to awareness, government initiative and cost of solar product.

Keywords: India, Solar Energy, Awareness, Public Readiness, Psychographic factors, Government initiative.

1. Introduction

India's economy is among the fastest-growing in the world, and one important measure of its growth is its Gross Domestic Product (GDP) (Dubey, 2023). As Indian economy is continuously growing, subsequently demand for energy is increasing, the Government of India needs to maintain balance between demand and supply of energy (Raghuwanshi & Arya, 2019). Roy & Schaffartzik, (2021) opined that India generates maximum of the energy from fossil fuels such as coal and excessive reliance on traditional sources of energy have caused adverse effect on the environment; to meet its energy demand and achieve sustainable economic development the government is making a gradual shift from conventional sources to renewable sources of energy. According to United Nation (n.d) "Renewable energy is energy derived from natural sources that are replenished at a higher rate than they are consumed." In the current scenario, the usage of renewable energy is crucial due to the scarcity of non-renewable energy sources like oil and gas.

Ministry of New and Renewable Energy Sources (MNRE) is the nodal Ministry of Government of India to look into all the aspects relating to Renewable Energy. MNRE has been granting both financial and non-financial incentives to all the states and union territories to successfully implement the projects and programmes related to renewable energy (Ministry of New and Renewable Energy Sources, 2012). The overview and status of renewable energy in India is highlighted as under:

1.1 Solar Energy: The Sun plays an important role in the growth and survival of the planet Earth. India's geographical area receives around 5000 trillion KWH of solar irradiation, with maximum of the states receiving 4-7 KWH per square meter per day. Over the years, India's solar energy sector has become an important player in the country's capacity for grid-connected electricity generation. The country's solar

potential has been estimated by the National Institute of Solar Energy to be at 748 GW. To promote the use of solar energy the Government of India has introduced various schemes such as Solar Park Scheme, Grid Connected Solar Rooftop and Defense Scheme etc. In India, as per latest annual report of MNRE on 31st December 2024, the installed capacity of solar energy was around 97.86 GW energy (Ministry of New and Renewable Energy Sources, 2025).

1.2 Wind Energy: After China, the United States, and Germany, India is the world's fourth-largest generator of wind energy with 48.16 GW of installed capacity overall (as of 31st December, 2024). The government is encouraging the private sector to participate in wind energy projects by offering a several monetary and fiscal incentives. National Institute of Wind Energy (NIWE) located in Chennai also extends technical support in assessing and identifying suitable sites for the projects. NIWE has successfully erected over 993 wind monitoring stations in the country. According to the most recent study, the country has a total wind energy potential of 695.50 GW. India has a coastline of roughly 7,600 kilometers which is enclosed by water on three sides. Offshore wind energy offers enormous potential for electricity generation energy (Ministry of New and Renewable Energy Sources, 2025).

1.3 Small Hydro Energy: According to their sizes capacity, hydropower projects are categorized into big and small hydro projects. The maximum installed capacity of Small Hydro Power Plants in India is 25MW. To promote Small Hydro Projects, MNRE implemented United Nations Development Programme - Global Environment Facility (UNDP-GEF) assisted Technical Assistance project in Hilly Regions of India. Hydro and Renewable Energy Department (HRED) evaluated the country's potential for small and mini-hydropower project power output at 21,133 MW from 7,133 locations energy (Ministry of New and Renewable Energy Sources, 2025).

1.4 Bio Energy: Biomass continues to be one of a significant source of energy in the country-offering certain advantages such as carbon neutral energy and source of employment generation in rural India. More than 70% of the population of the country relies on biomass for its energy needs. To make the best use of nations biomass resources for grid power generation, Biomass power and Cogeneration Programme is initiated. According to recent research funded by MNRE, India now has an estimated 750 million metric tonnes of biomass available each year. As of October 31, 2022, the Biomass Power and Cogeneration Sector have installed a total capacity of 10,205.61 MW. Another bio fuel includes Biogas which is produced in Biogas Plant from Bio degradable waste through a process of Anaerobic Digestion. In Anaerobic digestion microorganism decompose organic matters without the presence of oxygen. To promote installation of Biogas Plant MNRE implemented schemes like New National Biogas and Organic Manure Programme (NNBOMP) and Biogas Power Generation (Off-grid) and Thermal energy application Programme (BPGTP) energy (Ministry of New and Renewable Energy Sources, 2025).

The use of conventional energy source has resulted in environmental issues like climate change, air pollution, and environmental damage. The environment is least harmed by renewable energy sources because they are clean. Renewable Energy is unlimited and can be used indefinitely for future generations. Raghuwanshi & Arya, 2019 opined that Indian economy is continuously growing and demand for energy is increasing, the authors also stated that Government of India needs to maintain the balance between demand and supply for energy as renewable energy sources helps to fulfill the extra demand for power.

Unlike hydro and wind power which requires large area for installation of infrastructure, solar energy is generally preferred by the public at large for generation of power as it is accessible for residential use and requires less space for installation of solar panels.

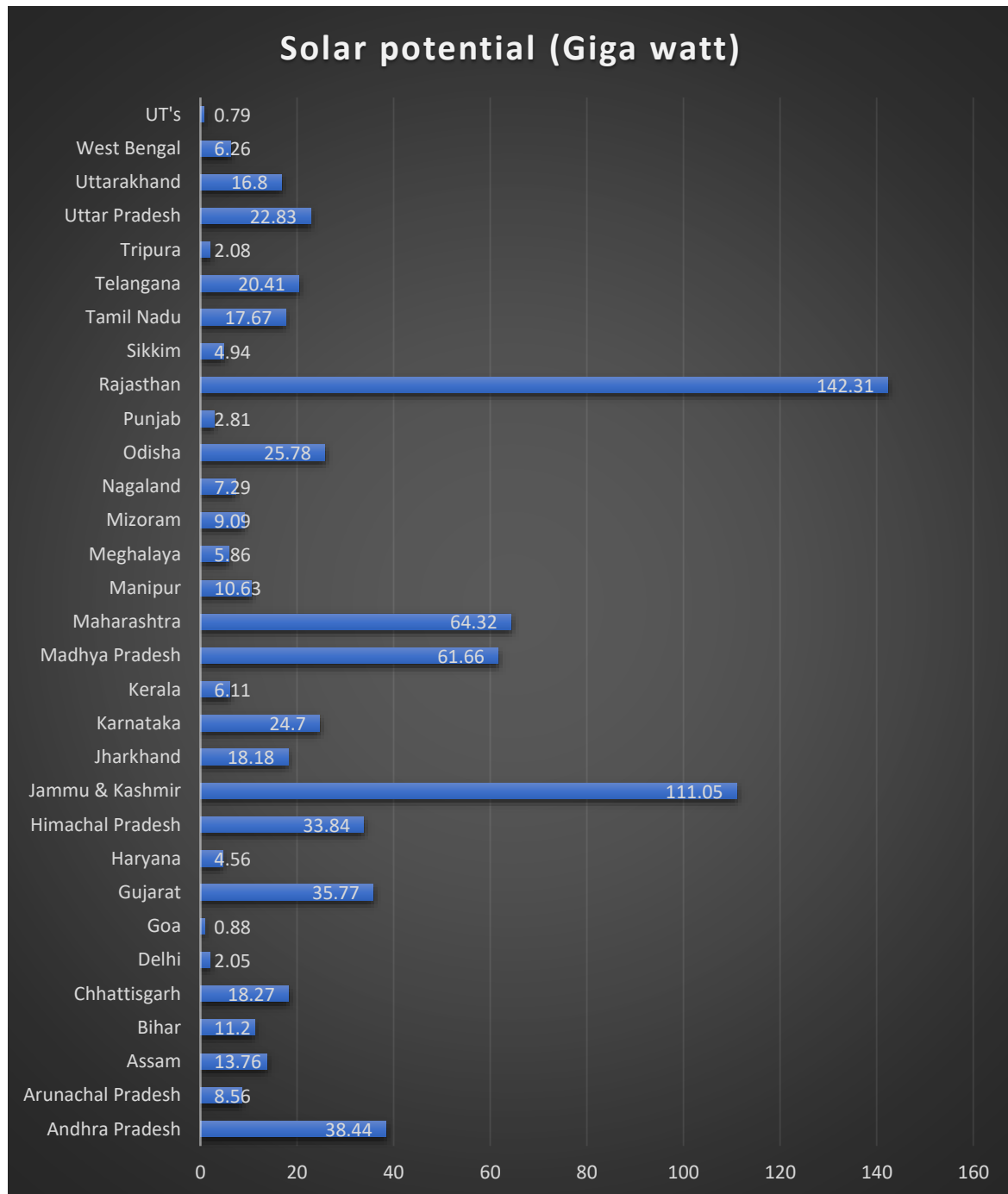
As per the reports of MNRE for the year 2024- 2025, the table and figures highlighted below shows the state wise solar potential and installed capacity of solar energy in the different states and union territories of India.

Table 1
Solar Potential and Installed Capacity of Solar Energy in states and union territories of India

Sl No.	State /UT	Solar potential (GigaWatt)	Installed capacity (Giga Watt)
1	Andhra Pradesh	38.44	4.7303
2	Arunachal Pradesh	8.56	0.0148
3	Assam	13.76	0.0185
4	Bihar	11.2	0.317
5	Chhattisgarh	18.27	1.3363
6	Delhi	2.05	0.2949
7	Goa	0.88	0.0526
8	Gujarat	35.77	16.7958
9	Haryana	4.56	1.987
10	Himachal Pradesh	33.84	0.1625
11	Jammu & Kashmir	111.05	0.0744
12	Jharkhand	18.18	0.1999
13	Karnataka	24.7	8.9869
14	Kerala	6.11	1.3137
15	Madhya Pradesh	61.66	4.9736
16	Maharashtra	64.32	8.9894
17	Manipur	10.63	0.0138
18	Meghalaya	5.86	0.0043
19	Mizoram	9.09	0.0304
20	Nagaland	7.29	0.0032
21	Odisha	25.78	0.616
22	Punjab	2.81	1.3871
23	Rajasthan	142.31	26.4897
24	Sikkim	4.94	0.00756
25	Tamil Nadu	17.67	9.5184
26	Telangana	20.41	4.8421
27	Tripura	2.08	0.0212
28	Uttar Pradesh	22.83	3.347
29	Uttarakhand	16.8	0.5931
30	West Bengal	6.26	0.3106
31	UT's	0.79	0.2133
TOTAL		748.9	97.64536

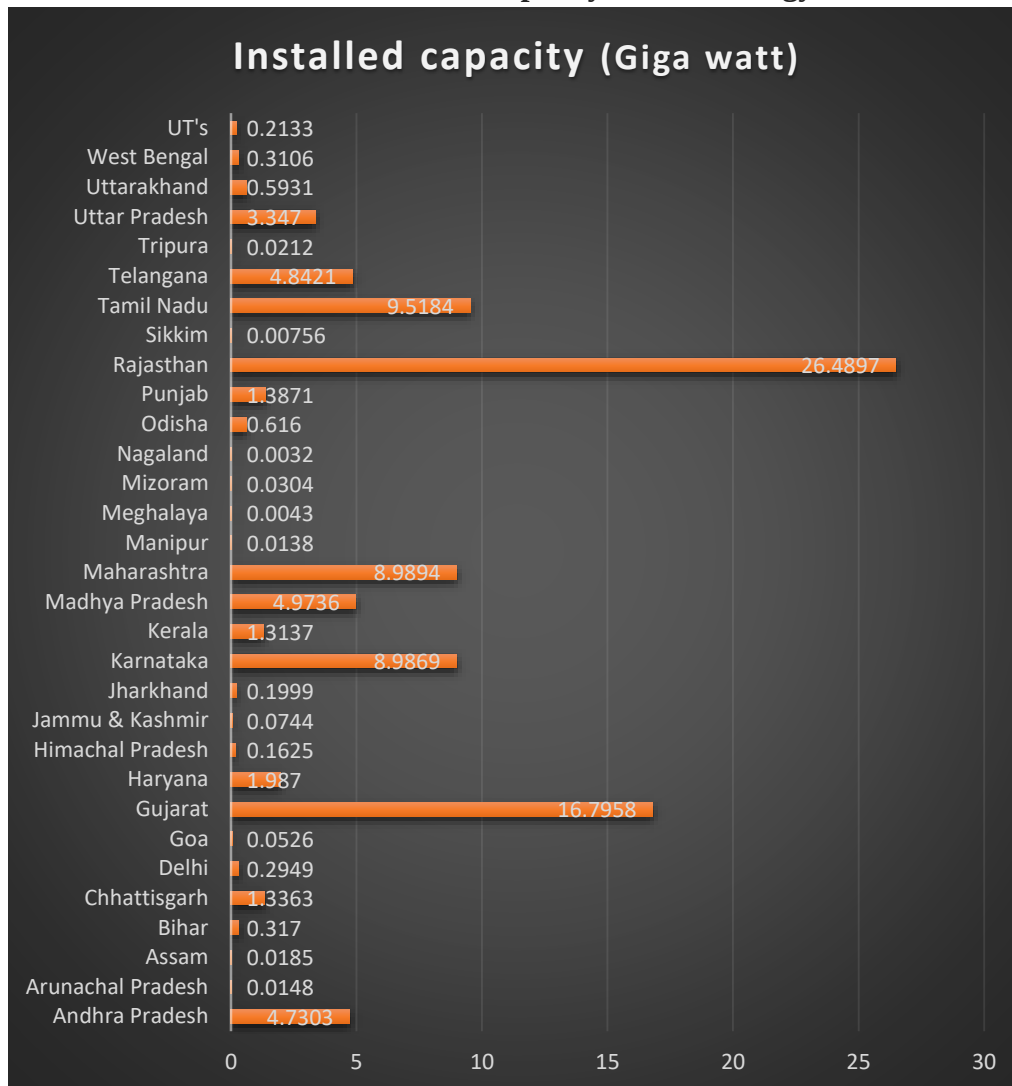
Source: Ministry of New and Renewable Energy, Annual Report 2024-2025

Figure 1
State- wise Solar Potential in India



Source: Ministry of New and Renewable Energy, Annual Report 2024-2025

Figure 2
State wise Installed capacity of solar energy



Source: Ministry of New and Renewable Energy, Annual Report 2024-2025

Despite having the total solar potential of 748.9 giga watt in India, only 97. 645 giga watt has been utilized which is less than 15%. The data shows there is underutilization of solar energy in maximum of states and union territories. Hence, this research paper focuses on the determining factors which hinders the adoption of solar energy in India.

2. Factors hindering the adoption of solar energy

This review paper analyses the existing literature and identifies the probable factors hindering the adoption of solar energy among the public in India. The factors discussed under are frequently addressed by other researchers. Hence, the author is revisiting those factors again.

2.1 Awareness of Solar Energy

Gupta & Saraswat, (2025) opined that awareness is a key factor affecting consumers' uptake of renewable energy. The degree of customers' perception and understanding of the facts surrounding renewable energy

technology is referred to as awareness. The public awareness about the solar energy determines whether they are ready to adopt the solar energy or not. Mishrif & Khan, (2024) conducted research to figure out the major barriers and readiness in installation of solar products among the public. The research concluded that 49% of the respondents were unaware of the solar energy but showed their willingness to install the solar products in near future. Yamaura et al., (2024) stated that the respondents exhibited low interest in installation of products. Moreover, most of the respondents showed low awareness and understanding about the renewable energy sources and the policy related to it. Mathilda et al., (2024) suggested that the awareness about the products among the consumers is essential to accelerate the adoption of solar technology in the country. Easwaran & Sudarve, (2024) examined the awareness level about the solar energy products in the Madurai district of Tamil Nadu. The results showed that the demographic factors are positively correlated with the awareness of the solar energy products. Dhiman (2020) concluded that the awareness level of the consumers and their desire to purchase sustainable products such as solar products differs among different income groups. Kalimuthu & Poovendan, (2024) stated that people are aware about the solar products but they are not aware about the benefits associated with it. Moreover, the respondents are not aware of the government incentives and subsidies associated with solar energy. Andrade-Arias et al., (2025) stated that the younger generation are more knowledgeable about the solar products and they are more likely to adopt. Khatke and Tamhane, (2021) opined that the lack of awareness reading solar products and financial constraints among the customers makes it difficult for marketing of Solar Products.

The public awareness about the solar energy determines whether they are ready to adopt the solar energy or not. The above literature review highlights that maximum of the public are not aware about the solar products and the schemes related with it. The maximum of the research suggests that to accelerate the adoption rate of solar products the public need to be aware of the solar energy technology and benefits associated with it.

2.2 Government initiative

Government initiative plays a vital role in generating intention to adopt solar energy among the public, moreover to promote adoption of solar energy products the government must provide subsidies, easy credit facilities and tax rebates (Kesari et al., 2021; Sun et al., 2020; Alam et al., 2021). Kumar et al., (2020); Bilal1 & Andajani, (2023)., opined that the government plays a significant role in increasing awareness and promotion of solar products in the country. Customers perceptions of solar energy goods are positively impacted by government initiatives. The government must target the market more effectively from a marketing strategic standpoint as well as understand the mindset and attitudes people have towards solar products. Ayoub et al., (2019) stressed that government can frame policies which are in favour of the solar product manufactures such as providing tax incentives on solar products, promotion of research and development in the fields of renewable energy and providing financial subsidies to the buyers of domestic solar appliances. Pandey & Kesari, (2017) stated that the rural population is reliable on the government projects to boost development in the field of clean energy. Wang et al., (2023) examined the impacts of government policies in increasing the green consumption behaviour and adoption of solar products among the residents. The result showed that the government environmental policies motivated the residents to adopt the solar products which ultimately lead to increase in green consumption behaviour and reduce the carbon footprints. The financial incentives provided by the government helps to reduce the burden of high cost of solar products on the customer (Nguyen et al., 2022).

The above review shows that government must play a crucial role in promoting solar energy products in the country. The public at large are still dependent on government initiatives to adopt the solar products. To reduce the cost burden of the solar products the government can frame schemes and programmes which will benefit the users of solar energy products. The initiatives taken by the government to promote solar energy will be fruitful only if the public will embrace it.

2.3 Public readiness towards adoption of solar energy

Coming to understanding of consumer readiness, according to Meuter et al. (2005) Consumer readiness is a condition or state in which a consumer is prepared and likely to use an innovation for the first time. By assessing the public readiness in context to solar energy products, it gives us an insight into whether the public are fully equipped with required knowledge and skills and ready to adopt the solar energy products. Technology Readiness Index (TRI) variables such as Optimism, Innovativeness, Discomfort and Insecurity were examined to determine the consumers readiness to adopt energy saving household products. Optimism and Innovativeness dimension of TRI have positive correlation with consumers attitude and readiness to adopt energy saving devices. Whereas Discomfort and Insecurity prevented consumers from having a positive attitude and readiness to adopt energy saving devices (Ali et al., 2019). Hasheem et al., (2022) concluded that technological readiness factors such as optimism and innovativeness significantly influence the customers attitude towards adoption of solar products.

Similarly, the cost of the product and financial aspects associated with the product also affects the readiness of the customers to invest in solar products. The factors such as high upfront installation cost, periodic maintenance and energy storage related issues affect the readiness to adopt of solar products among the public (Rengasamy et al., 2020). The readiness to invest and adopt solar energy is hampered by long term investment return and lack of awareness regarding installation of solar devices (Hai et al., 2018). The lack of proper knowledge and awareness about solar energy are also the reasons for slow adoption of solar energy (Khoo et al., 2023). Srivastava et al., (2016) opined that high price of green products affects the readiness of buyers to purchase. The public readiness is a crucial factor while deciding the adoption of renewable energy product. In most of the studies apart from other factors, the cost associated with solar energy product hampers the public readiness to adopt solar energy.

The public readiness is a crucial factor while deciding the adoption of solar energy product. In most of the studies apart from other factors, the technological readiness and cost associated with renewable energy product hampers the public readiness to adopt renewable energy. The decision of public to adopt the product is still hampered by the high cost of the solar products. The lack of personal traits like innovativeness and optimism about using the new product also plays a crucial role in deciding the readiness of public to embrace the technology.

2.4 Psychographic factors

Psychographic segmentation helps to know exactly what people are thinking and how it affects their decision making. By using psychographic segmentation, the marketers can develop the products according to the needs and wants of a customer. Allen et al., (2025) opined that psychographic factors are more important and crucial in influencing the sustainable purchase behaviour compared to demographic factors. Similarly, Ishola et al., (2024) also concluded that it is important to use the psychographic factors in segmentation of customers who are willing to purchase solar energy. According to Lin & Syrgabayeva, (2016) psychographic factors such as environmental knowledge, concern, belief and attitude towards renewable energy influence the decision of consumer's willingness to pay more for renewable energy. Ganeshwaran, (2023) opined that personality traits such as customer innovativeness was more crucial than

environmental concern and ecological lifestyle in influencing the customers to install the solar rooftop panel. Gray et al., (2025) stated that green consumer tends to be environmentally conscious and inclined towards achieving sustainable development. The green consumers are engaged in activities such as conserving energy and recycling. The personality characteristics of green consumers are open to change, conscientiousness and self-transcendence. Psychographic variables such as health consciousness and perceived consumer effectiveness have a significant role in influencing green purchase intention among the customers. The marketers need to consider these variable while formulating their marketing strategies (Raluca-Mihaela & Mihaela, 2016). Gupta et al., (2025) explores the relevance of psychographic and demographic factors in green consumer segmentation. Three main customer groups were determined to be: Eco-Activists, Pragmatic Green Consumers and Indifferent Consumers. The psychographic characteristics suggests that Eco activist group are concerned about environment and are interested in environment conserving activity. The pragmatic groups are concerned about environmental problems but they are influenced by the price of sustainable products to a great extent. Indifferent Consumers are not affected by the activities of environmentalist and are unaware of adverse effects of environmental problem. According to Redaputri et al., (2024) adopting rooftop PV as a more sustainable energy option requires pro-environmental behaviour (PEB) in the community. The opinions of individuals with respect to the economic and environmental advantages of pro-environmental behaviour are greatly influenced by psychographic aspects such environmental awareness, economic awareness, reliability awareness, and ecologically friendly look. Gray et al., (2025) examined the psychographic factors which the green consumers exhibit. Before buying a product, green consumers lay emphasis on adverse impact of the product on environment. The green consumer tends to be environmentally conscious and inclined towards achieving sustainable development. The green consumers are engaged in activities such as conserving energy and recycling. The personality characteristics of green consumers are open to change, conscientiousness and self-transcendence.

Psychographic segmentation is a crucial strategy for promoting products based on the requirements and desires of customers. It provides useful details on the lives and personalities of customers for effective communication. The people who are environmentally conscious are more likely to adopt and willing to pay for the solar products. The eco activist people are concerned about the environment and believe in achieving development in a sustainable manner. The green consumers mainly focuses on buying products which causes least harm to the environment.

3. Findings of probable problems encountered by people in relation to Solar Energy

According to the above discussed literature review, the author has identified the following probable problems encountered by the public with regards to adoption of solar energy:

1. Lack of product awareness among the people about the availability of solar energy products (both virtual and store) and various state/central government schemes related to solar product(s).
2. Fear of product failure after paying a substantial amount, also, high initial and maintenance cost of the solar products are major concerns of the people.
3. People are skeptical about the quality of products available in the market.
4. Due to lack of technical person and non-availability of spare parts, the Solar Photovoltaic devices are discarded soon.
5. Poor Customer Relationship Management (CRM) of the seller/firms.

6. Frequent changes in policies of the government without the involvement of stakeholders were causing delays in project relating to renewable energy.
7. The ecologically conscious customers tend to buy products which are environmentally friendly, but they are also concerned about the price of the solar products.
8. The innovativeness trait also influences the public while purchasing high tech products.
9. Residential owners specially rural residents are not satisfied with the limited financial incentives, unreliable suppliers and lack of clear technical information.
10. Few product options available in the market.
11. Solar energy is affected by unfavorable climatic conditions which lead to fluctuation in power generation.

The adoption of solar products is mostly affected by the low awareness level of the public about the product and their failure to take advantage of available government schemes and benefits. The government still needs to focus on promotion of solar products and the policies related to solar products. the public at large need to be sensitized about the positive impact of solar products on the environment and the advantages associated with it compared to conventional sources of energy.

4. Suggestions

Based on the above probable problems the following suggestions have been proposed by the authors.

1. The government should provide adequate financial assistance, such as subsidies, tax benefits and easy access to credit facilities for the consumers to purchase the products.
2. The government along with the Non-Governmental Organization (NGO) should focus on conducting awareness campaign, sharing success stories and educating people about the benefits and use of renewable energy.
3. It is important to convey the personal benefits that consumers will derive from using solar energy products.
4. Solar devices should be made affordable by providing tax benefits to the manufacturers to reduce the price of the product so that people with low incomes can purchase them.
5. To stop the imports of low-quality solar products.
6. The Government, companies and educational institutions should tie up and invest in research and development to provide better quality, low cost and customizable products.
7. The government should organize campaigns and programmes to sensitize the public about the schemes related to solar energy.
8. The manufacturers of solar products can make use of digital and social media platforms in maintaining positive relation with customers and spreading awareness about solar energy.
9. The manufacturers also need to provide detailed demonstration on how to operate the product efficiently.
10. Tax incentives and benefits should be provided to those companies who are engaged in boosting the solar energy sector in the country.
11. To setup Technical Training Centers which will enhance the skills and knowledge of individuals in various technical fields related to solar energy.
12. Involvement and participation of all the stakeholders in policy making process will be the important factor in successful implementation of government policies and programmes.

To promote the use of solar products among the public, it is important to create awareness about the solar products and the government schemes related to solar products. The government must continue to support the promotion of solar products by framing favourable policies and schemes. The marketers need to focus on developing effective marketing strategy with special focus on psychographic profile of customers to attract the public towards adoption of solar products.

5. Conclusion

Renewable energy will play a critical role in meeting the future energy needs which is essential for the economic growth of the country. To achieve Sustainable Development, utilization of renewable energy is the need of the hour. While the prospects for renewable energy are promising, challenges remain. India is one the leading countries in the world in terms of utilization of renewable energy. In India, MNRE is the nodal agency implementing all the policies and programmes related to renewable energy. MNRE is continuously involved in activities which will boost the renewable energy sector in India. The financial incentives, government programmes and policies related to renewable energy are disbursed to all the states and union territories. Public must be encouraged to use solar products to light up homes and heat water using solar water heaters. The government can provide reasonable financial incentives and technical assistance to people for buying solar products. Despite the problems and limitations, with continuous research, technology improvements, and legislative efforts aim to overcome them and accelerate the use of solar energy.

The problem which was encountered by people is still the same as the author found out from the review of literature. Several questions remain unanswered eventually leading to negligible percentage of people adopting solar energy.

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