Adoption and Diffusion of Solar Products in Indore : A Study on Barriers for Non - Adoption of Solar Energy Systems in Domestic Households

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Abstract

An ever increasing consciousness towards sustainable development and environmental conservation has laid an emphasis on replacing conventional energy sources by renewable energy systems. In line with Clean and Green India movement, a study was conducted among individual households/owners in Indore, Madhya Pradesh which was aimed at identifying the adoption and diffusion of solar products like solar inverters, solar water heating systems, and solar lights to name a few. The study mainly focused on the barriers in adoption of solar energy and also the perceptions of domestic users about solar energy products were studied on the basis of variables like cost, awareness among people about various governmental initiatives, environmental awareness, relative advantage of using solar power over conventional energy sources, etc. The findings of the study revealed that though people were environmentally conscious and were aware about the advantages of using solar products but the perceived high costs, financial constraints, lack of awareness about governmental initiatives, and lack of promotional activities were some of the major barriers which led to non-adoption of solar products as a renewable energy source. The findings may help in predicting the purchase patterns of individual customers for solar products, and thereby in designing marketing strategies, creating awareness about solar products, and increasing the use of renewable energy sources among individual households.

Keywords : **Barriers to adoption and diffusion of green products, energy saving, Indore, solar energy, sustainable development**

JEL Classification : M10, M30, M31, M38

Paper Submission Date : June 15, 2018 ; Paper sent back for Revision : December 5, 2018 ; Paper Acceptance Date : February 18, 2019

Amidst ever growing energy crisis, depleting conventional fuel resources like coal, petroleum, and natural gas to name a few, and degrading environment, the world today is trying to focus on certain alternative solutions which can be sustainable and convenient to adopt and implement. The efforts to find such technologies started long back in the early 1970s with Stockholm conference on environment protection (1972), Montreal Protocol on phasing out of green house gases (1989), RIO Earth summits (1992 and 1997), and Kyoto Protocol (for setting internationally binding emission reduction targets) to name a few. Consequently, Conference of Parties (COP) are held every year under the aegis of United Nations Framework Convention on

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DOI : 10.17010/pijom/2019/v12i3/142338

Climate Change (UNFCCC) to assess the progress made in dealing with climate change (United Nations Climate Change, 2015).

The Working Group I (Organisation for Economic Co-operation and Development, 2012) in their report (IPCC, 2013 Paris Conference) stated that human influence on the climate involves producing greenhouse gases and the use of energy represents by far the largest source of emissions. To reduce carbon footprints, technology shifting from conventional resources, and increase of use of non conventional energy resources is becoming pertinent. In recent developments, during the COP22 at Marrakesh on November 15, 2016, the International Solar Alliance (ISA) framework agreement was opened for signatures from all solar rich countries which lie between the tropics of Cancer and Capricorn (Ministry of External Affairs, 2017). The latest ISA summit was held in March 2018 at New Delhi where a framework for sensitization programs for stakeholders was presented so as to increase awareness about solar energy systems and their implementation in rural and urban areas of its member and prospective member countries. India being its founder member is playing a major role in developing strategies to increase the adoption of solar energy systems (Sraisth, 2018).

In the year 2016, United Nations Sustainable Development Goals (SDGs) were set up (in continuation of Millennium Development Goals for the period 2000-2015) which stressed on zero poverty, zero hunger, good health, quality education, gender equality, clean water, and sanitation, clean and affordable energy(SDG7), sustainable cities (SDG11), responsible consumption, climate action, unpolluted oceans and land, decent work and economic growth, innovation, reduced inequalities, and partnerships to achieve the goals by the year 2030 (United Nations, 2015).

In line with the SDGs wherein 191 countries have pledged to adopt methods and work towards making the world a better place, India has also committed itself to have renewable energy account for 40% of installed capacity by 2040. The targets achievable by 2022 include 175 GW from renewable of which 100 GW will come from solar power, of which the country has added more than 12.2 GW of solar capacity in the three years from March 2015 upto March 2018, starting from a low base of 2.6 GW in 2014. (Ministry of New and Renewable Energy, Government of India, 2018). Further, the solar power capacity target set under Jawaharlal Nehru National Solar Mission was upped five times from 22 GW to reach 100 GW by 2022, with an investment of ₹ 6 lakh crores (Dogra, 2018). This is to be achieved principally by generating 40GW through rooftops and another 60 GW from large and medium scale grid connected solar power projects.

As such, solar technologies exist mainly in two forms, which are solar photovoltaics (SPVs) and solar thermal technology. Solar water heating systems or solar geysers are the most popular solar thermal systems along with solar cookers where concentrated solar radiations act as an energy source to produce electricity. Among SPV, solar home systems (SHSs), street lights, rooftop SPVs, solar pumps, and solar lanterns can be used in urban and rural areas to minimize dependency on conventional electricity sources and reduce the demand-supply energy gap. The solar PV systems may work in on-grid, off-grid, and hybrid modes. In on-grid or grid connected solar power systems, power produced by solar panels is used by the establishment and extra power is transferred to the grid can be sold to the utility company (for example, MP Electricity Board) using Netmetering. Off-grid solar power systems are Stand-Alone Power systems(SAPS) where grid connectivity is not there and storage systems or batteries are required to store the energy produced by solar panels.

Various states like Rajasthan, Andhra Pradesh, Kerala, Karnataka, Gujarat etc. have already started working on planning and implementation of solar policies framed at central as well as state levels. In Madhya Pradesh also, amongst numerous initiatives, world's largest solar power of 750 MW is being set up at Rewa, Madhya Pradesh (Rewa Ultra Mega Solar Project RUMS). A historic deal between three major players have worked out the unit cost as low as ₹ 3.30 levelled for the next 25 years. The first year tariff would be even low at ₹ 2.97 per unit as against ₹ 3.30 per unit of electricity currently supplied by Government run NTPC (National Thermal Power Corporation) (The Outlook Magazine, 2017).

Since Madhya Pradesh is strategically located and incidentally houses 14 districts lying on Tropic of Cancer, it

is a solar energy abundant region. The state is endowed with high solar radiation with around 300 days of clear sun and offers good sites with potential of more than 5.5 kwh/sq.m./day for installation of solar based projects. As far as land requirements are concerned, Madhya Pradesh is the second largest state area wise and has large tracts of unused and undeveloped land which can provide attractive opportunities for solar installations (New and Renewable Energy Department, Government of M.P., 2012).

However , the solar installed capacity constitutes only 1.62% (7.25MW) of the total renewable energy installed capacity in the state (New and Renewable Energy Department, Government of M.P., n.d.a.) which leaves a lot of potential in this area and needs to be evaluated.

The main area of thrust in this research is understanding the buying behavior of customers regarding solar products and finding out gaps which have blocked this abundant energy source to be fully tapped.

Literature Review

In the current scenario where much emphasis is being given on green energy initiatives and sustainable development, role of solar power as a major energy source cannot be undermined. Though many studies have been undertaken in this area in western countries, much work remains to be done in the Indian context. With many governmental initiatives in the pipeline, things are seemingly brightening. The government is providing ₹ 15000 crore as capital subsidy to promote the massive expansion of rooftop solar projects in towns and cities. The central subsidy presently covers 30% of the expenses incurred in installing a small rooftop solar plant (Dogra, 2018).

In Madhya Pradesh, many large solar installations have been done at railway stations at Habibganj (Sood, 2017), Indore, Neemuch, and Ratlam ("Indore railway station gets 20 kw solar power plant," 2015), Ujjain ("Ujjain railway station goes green", 2018) and also at Badarwas, Kolaras, Shivpuri, Mohna, and Panihar ("Solar power lights up 5 MP stations", 2012), and Police Headquarters, Bhopal ("Police headquarters sets up 100 KW solar power plant," 2016) to name a few. However, solar products have not received a proper ground which should have they got especially, in domestic household markets taking into account the various advantages they have over non-green energy sources. Adoption of this relatively newer concept in India is necessary and challenging at the same time.

Many of the studies carried out at international levels for adoption and diffusion of renewable sources of energy are mostly based on Roger's model, Technology Acceptance model (TAM) and Theory of Reasoned Action (TRA). To understand the major blocks (non-technical barriers) towards lesser adoption and diffusion of renewable energy sources, Margolis and Zuboy (2006) cited reasons like lack of governmental initiatives, lack of information dissemination, and consumer awareness about energy efficiency and renewable energy (EE/RE), high cost of solar energy systems, insufficient financial funding / loan schemes etc., poor perception about EE/RE, lack of active participation of various stakeholders, and communities in these projects.

As per Timilsina, Kurdgelashvili, and Narbel (2012), solar PV were considered to cater to a niche market mainly electrifying rural and semi urban areas where grid power was not available. However, such areas were characterized by low income groups which could not afford high capital expenditure and depended mostly on subsidies and unfortunately, government subsidies or international donations are not a long-term solution.

Negro, Alkemade, and Hekkert (2012) in their study regarding diffusion of renewable energy discussed certain systematic problems like market structure, infrastructure (physical and knowledge), institutional problems, interaction problems, and capability problems which hampered or slowed down the diffusion process of Renewable Energy Technologies (RETs) since they were newer, innovative, and a part of a very different energy system as from the existing ones.

Thiede (2014) elaborated several factors regarding adoption rates of solar and wind energy products in the state of Minnesota (USA) . He referred to Au (2000) and Rogers diffusion of innovation models (Rogers, 1995), which

were explained by five attributes of the innovation which are explained as follows :

- **Relative Advantage :** The marginal advantage an innovation has over existing products.
- **Compatibility :** How the innovation fits with an adopter's values, attitudes, and behavior.
- **Observability :** How visible the innovation is.
- **Trialability :** How accessible the product is for individuals to use on a trial basis.
- **Complexity :** The operational ease and understanding about the innovation or its principles which generally acts as a restrictive factor in adoption.

Regarding use of sustainable energy resources and consumer behavior towards adoption or non-adoption of green energy, Rettie, Burchell, and Riley (2012) learned that consumers did not just want to go for different products but they wanted just normal products and hence, de-emphasizing the 'greenness' of environmentally beneficial actions and focusing more on normalized goals like cost savings helped increase adoption among a broader audience.

Indian scenario as far as adoption of RES is concerned is studied by many researchers and some of the studies are referenced as follows:

Nath, Kumar, Agarwal, Gautam, and Sharma (2012) listed low functional performance of green products, lack of availability, lack of support services, high price, and difficulty in integration with normal routine to name a few, being the major barriers in adoption of green products.

In their study, Upadhyay and Chowdhury (2014) discussed the technical and functional aspects of various solar technologies, and their contribution towards the demanding power sector. However, certain technical, economic, and institutional barriers were weakening the adoption of these technologies. For instance, storage was a major concern for standalone/off-grid PV systems. Procurement, maintenance, and safe disposal of batteries are also challenging.

Mittal and Mital (2016) referred to USAID (2013) wherein following barriers against energy efficiency were found :

(i) Policy barriers	(ii) Institutional barriers
(iii) Barriers related to end users and project developers	(iv) Financial barriers
(v) Voluntary nature of policy measures	(vi) Limited capacity of institutions
(vii) High cost of energy efficient products	(viii) Limited technical knowledge
(ix) Lack of internal funds	(x) Split incentives between energy service companies (ESCOs) and owners
(xi) High transaction cost due to small project size	(xii) Communication gap financers and project developers

Some studies have already been undertaken in the states of Maharashtra, Punjab, Karnataka etc. regarding consumer behavior towards solar products. However, much work needs to be undertaken as far as Madhya Pradesh is concerned. The study area for this research was Indore and can be expanded further for the whole state. Indore being the commercial capital of M.P. is the most populated district as well and hence, justifies the reason for being taken as the pilot area for the study.

Objectives of the Study

The objective of the study was to explore and identify the probable factors which affect customer's perceptions

about solar products in Indore and finding about the gaps / barriers which prevent them towards adoption of these products. This led to some pertinent questions such as :

Q1) What is the general perception /awareness of individual households in Indore about solar products ?

Q2) What are the main barriers which prevent them from knowing about or using solar products ?

Research Methodology

According to Joseph and Korlekar (2012), there is a scope for in-depth studies on green marketing to be conducted in developing countries like India, not only on understanding consumer perception, but to study the detailed profile of such consumers who have a more positive attitude towards green marketing and green products.

In line with above, solar energy being one of the most abundant green energy sources, an understanding of consumer perception and their attitudes towards this, needs to be studied in depth. Our study was carried out among the non-users of solar products in Indore, the commercial capital of Madhya Pradesh.

(1) The Study : The study was descriptive in nature and was aimed at identifying the factors which act as barriers to the adoption and diffusion of solar products in Indore, Madhya Pradesh.

(2) The Sample : A sample of around 200 individual households of Indore city who do not use solar products (non-users) was taken based on convenience sampling. Of the total 200 questionnaires, 169 were complete in all aspects making them the source for data analysis. The study period was from November 2017 to February 2018.

(3) Tools for Data Collection : The data was collected with the help of a self designed questionnaire which was prepared after a review of existing literature. Secondary data sources included government publications, websites, survey reports, and research papers .

(4) Questionnaire Format : Besides the demographic data, 24 variables were considered which are related to the relative advantage of green products, especially solar, awareness about governmental initiatives, cost, operability/feasibility vis-à-vis existing setup or modifications required, readiness to adopt solar products to name a few. Responses regarding perceptions and awareness of the respondents were taken on a 5-point Likert scale ranging from *strongly agree* (1) to *strongly disagree* (5).

(5) Data Analysis : Factor analysis was done on the data collected from various parts of Indore. Varimax rotation method was used with KMO (Kaiser-Mayer-Olkin) Normalization and Bartlett's test which determine the factorability of the matrix as a whole. Principal component analysis was done on the variables obtained in order to construct some new variables affecting the adoption of solar products with respect to individual households.

Analysis and Results

In order to find out major contributors out of multitude of variables, Exploratory Factor Analysis was done to clearly define the perceptions of respondents towards solar products.

(1) KMO and Bartlett's Test : First, the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was calculated as 0.710 (Table 1) which is much greater than the threshold value of 0.5 to make the sample adequate for factor analysis (Hair, Black, Babin & Anderson, 2014). Bartlett test of sphericity resulted in significance of 0.000 indicating that the data was approximately multivariate normal and acceptable for factor analysis, measuring the correlation between variables (Table 1).

Next step was determining and consolidating the factors affecting adoption decisions for solar products and

why the respondents had not gone for alternative energy sources. This was determined by using Principal Component Analysis (PCA), which assumes sample as population and leads to grouping of variables based on strong correlations among themselves. The communalities extracted through PCA peaked at 0.840 and showed the interrelatedness of the items or the factors with all other items. The consolidation of factors was done and 24 variables were grouped into eight factors.

(2) Eigen Values and Scree Plot : The Eigen values represent the amount of variation explained by a factor. As per Kaiser rule , we should drop all components with Eigen values under 1.0, this being the Eigen value equal to the

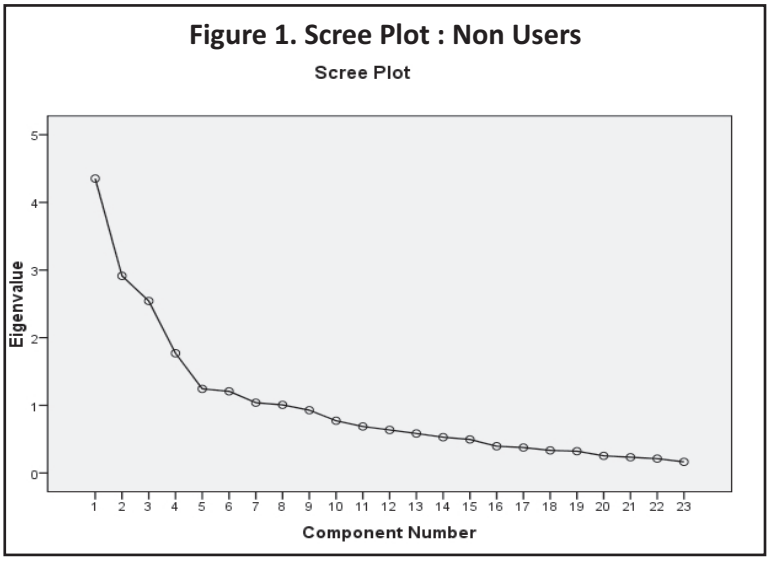
Table 1. KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.710
Bartlett's Test of Sphericity	Approx. Chi-Square	1.488E3
	Df	276
	Sig.	0.000

Table 2 . Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.532	18.884	18.884	4.532	18.884	18.884	3.579	14.914	14.914
2	2.915	12.147	31.031	2.915	12.147	31.031	2.241	9.337	24.251
3	2.597	10.821	41.852	2.597	10.821	41.852	2.109	8.788	33.039
4	1.774	7.392	49.244	1.774	7.392	49.244	2.047	8.527	41.567
5	1.311	5.464	54.709	1.311	5.464	54.709	2.018	8.408	49.974
6	1.213	5.056	59.765	1.213	5.056	59.765	1.710	7.127	57.101
7	1.121	4.669	64.434	1.121	4.669	64.434	1.585	6.604	63.705
8	1.034	4.309	68.743	1.034	4.309	68.743	1.209	5.038	68.743

Figure 1. Scree Plot : Non Users



information accounted for by an average single item. All factors with Eigen values greater than 1 are retained. Table 2 displays the eight factors whose Eigen values were more than 1.0 and accounting for almost 70% of the total variance and hence, retained. Rest of the items were ignored.

The results were supplemented by the Scree plot Non Users (Figure 1) which showed that the curve started to flatten after the 8th factor. The scree plot orders the Eigen values from largest to smallest, shows the Eigen values on the *Y*-axis corresponding to the value of factors on the *X*-axis, and the elbow shown provides a fairly reliable criterion for factors selection (Abbas, Gravell, & Wills, 2010).

The factors so obtained were visible in the component matrix and rotated component matrix which contain the loading of each variable onto each factor and simplified version for easy interpretations. The factor groups were then given a new nomenclature based on the loadings of variables and their contribution to the individual factors (Table 3).

Table 3. The Extracted Factors with Their Related Variables

No.	Factor Name	Variables	Factor Loading	Total Factor Loading	Percentage of Variance
1	**Policy Awareness**	Awareness about :			
		Toll free number of MP Govt.	0.872	3.677	14.914
		MP Urja Vikas Nigam	0.828		
		Website of MNRE, MP government	0.805		
		Solar power plants in M.P.	0.680		
		Rain and clouds	-0.492		
2	**Promotion**	Information about :			
		Advertisements about solar energy products	0.757	2.143	9.337
		Live demonstrations of solar products	0.776		
		Operational or technical features	0.610		
3	**Vicinity**	Information about :			
		Maintenance cost by nearby adopters	0.876	2.097	8.788
		Adopters of solar products in the neighbourhood	-0.639		
		Information about sellers in the neighbourhood	0.582		
4	**Adoptability**	Status on :			
		Ready to adoption status	0.771	2.300	8.527
		Role model for adoption of green energy	0.576		
		Societal image if green methods are adopted	0.520		
		Awareness about subsidy by government if solar energy systems are adopted	0.433		
5	**Place**	Lack of proper installation space	0.860	1.373	8.408
		Unwillingness to change existing setup	0.513		
6	**Ecoliteracy**	Observed traffic lights / signals being run on solar power	0.773	1.804	7.127
		Knowledge that solar energy saves electricity	0.563		
		Knowledge that green products are available in the market	0.468		
7	**Environmental Consciousness**	Use of solar energy is a must for smart city	0.861	1.443	6.604
		Green energy saves environment	0.582		
8	**Price**	Initial cost of the solar products	0.884	0.884	5.038

The factors derived are made up of variables individually shown in Table 4, which has the rotated component matrix, also certain blank spaces are seen for some variables because we have opted for suppression of factor loadings less than 0.3. The various factors so obtained are displayed in Table 3, and can be elaborated and explained as under :

(1) Factor 1 - Policy Awareness : Lack of awareness about governmental initiatives emerged as one of the most important factors with a percentage variance of 14.864 and factor loading of 0.549 to 0.872. It comprised of five items like customer knowledge about solar plants in Madhya Pradesh, websites of government regarding solar energy, toll free numbers, and M.P. Urja Vikas Nigam, and Akshye Urja Shops run by the government at district and block levels, and user friendliness of solar products. It was observed that there has been a lack of awareness on the part of respondents as far as government initiatives are concerned. In his working paper on barriers to adoption of Renewable Energy Technology (RET), Doner (2007) discussed the critical role policy makers had to play in order to make RETs competitive with fossil-fuel technologies. He concluded that it was important to make

Table 4 . Rotated Component Matrix

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a.Rotation converged in 12 iterations.

Awareness about Toll_free_no	0.872						
Awareness about UrjaVikas Nigam	0.828						
Visited websites of MP Government	0.805						
Awareness about setting up of solar power plants in MP	0.680						
User friendliness of solar products	0.549						
Effect of weather	-0.492						
Not seen live demos of the product		0.776					
Not seen any advertisements		0.757					
Operational knowledge		0.610					
Solar products have high maintenance costs			0.876				
Neighbours who use solar products			-0.639				
Awareness about nearby sellers			0.582				
Readiness to adopt				0.771			
Becoming a role model for others towards energy conservation				0.576			
Positive image in society				0.520			
Knowledge about government subsidy				0.433			
Proper space availablity					0.860		
Changes required in setup					0.513		
Observed traffic lights						0.773	
Saving on electricity bills						0.563	
Product availability						0.468	
Awareness about green energy management in a smart city							0.861
Saves environment							0.582
Solar products are costly							0.884

policies predictable and stable for a long-term so that it was easier to get financial assistance from banks and this in turn would reduce risk and uncertainty. This was also emphasized by Kansal and Pathania (2016) in their study regarding consumer perception and acceptance of solar products in Punjab wherein, lack of governmental initiatives and high costs were found as the major barriers in diffusion of solar products.

(2) Factor 2 - Promotion : Lack of promotional activities like advertisement, demonstrations etc. formed the second factor. It also included lack of knowledge about operational and technical aspects of solar products. The component yielded 10.071% of variance and factor loading ranged from 0.610 to 0.776. The results were in line with a survey conducted by Mercom Capital Group LLC (2014) wherein, it was found that despite the higher favour, respondents gave solar relative to other generation sources, a general lack of education and awareness, and in some instances misconceptions about solar, such as its use being limited to water heating still persist. Further, there has been a very little effort on part of solar industry to educate consumers and undertake promotional activities like live demonstrations, advertisements on popular media like TV and radio to name a few.

(3) Factor 3 - Vicinity : Neighbourhood impacts and interpersonal interactions formed the third factor wherein respondents' knowledge about nearby sellers, maintenance costs of the solar products, and knowledge about neighbours having solar installations were the components, the variance being 9.08% and factor loadings ranged from 0.582 to 0.876. Jackson (2014) in his study found that diffusion of new products such as microfinance depended upon many characteristics of the network. According to him, the concept of homophily, that is, like mindedness or tendency of people to interact with similar individuals was a very crucial factor in taking economic decisions.

(4) Factor 4 - Adoptability : This included factors like enhancement in social image if adoption of green energy is done, posing as role models for non-adopters and adoption readiness status accounted for 8.994% of variance with factor loading ranging from 0.408 to 0.854. Ali and Yadav (2018) in their study in rural areas of Munger district (Bihar) found that in case of off grid systems in rural areas, a thorough understanding of the customer's needs and then customizing and innovating the solar products can play a key role in increasing the adoptability of the product, and make the energy deprived self-sufficient.

(5) Factor 5 - Place : Infrastructural challenges like lack of installation space, unwillingness to change the existing set-up etc. formed the fifth factor with 8.722 % of variance and factor loading ranging from 0.513 to 0.860. It was observed that people were resistant to changing their existing set-up in order to get the major installations done, for example, laying of pipelines, cabling etc. in case of solar water heaters and rooftops. Faiers and Naeme (2006) had mentioned in their study that solar systems remained unattractive to individual householders as a home improvement and were incompatible with personal priorities. Also, in case of rented accommodations, the respondents were not the deciding factor in solar installations. Similar facts were found in urban areas of places like Hong Kong. Karakeya and Sriwannawit (2015) found that inadequate installation space was a key barrier for rooftop integration. In old high-rise buildings, the surface was simply too limited. However, designing of newer buildings could be done in such a way that installation space was available for PV systems.

(6) Factor 6 - Ecoliteracy : Awareness about Green Energy formed the sixth important factor. It was observed that people were aware of the relative advantages of green energy over conventional sources, for example, power saving, environment protection etc. Most of them had observed solar panels installed at traffic signals, plus, they were also aware of various solar products in the market, for example, solar water heaters, solar lights, solar cookers, and solar lights. The factor accounted for 7.3245 of variance with factor loading of 0.468 to 0.773. In

their study, Cheah and Phau (2011) found that eco-literacy, that is, awareness about environment friendly products created a favourable attitude, and more susceptibility to purchase green products.

(7) Factor 7 - Environmental Consciousness : The respondents were aware of the fact that solar energy is an important source of energy which is non polluting and has a very low carbon emission rate which leads to protection of the environment. Another item here was that Indore being designated to be developed as a smart city, so adoption of energy saving techniques was a must. The variance for the factor was 6.587% and factor loadings were 0.582 to 0.861.

(8) Factor 8 - Price : High initial cost was the single important factor accounting for 5.133% of variance and factor loading of 0.884. Reddy and Painuly (2004) in their study discussed that quite a number of consumers considered high initial costs as a key factor in non adoption of RESs (Renewable Energy Sources). Though minimized operating costs over a long period of time offset the competitively high prices, still due to low disposable incomes, and less access to financial assistance, there was very less diffusion of Solar Water Heaters (SWHs). Mittal and Mital (2016) found that energy efficient technologies were capital intensive and lack of funds discouraged end users to try and adopt these technologies.

Managerial Implications

The study which mainly included non-users of solar products in Indore could find that despite having knowledge about advantages of solar energy, people were not yet adopting this energy source fully and diffusion of solar products was not uniform. Some of the factors responsible for non adoption of these products are identified as lack of awareness about governmental initiatives, lack of awareness about the products and the contact points (sellers / agencies to be approached etc.), perceived high initial costs, lack of enough financial resources, installation challenges like lack of space, changes in existing set-ups etc., long pay back periods mainly in case of solar rooftops and water heaters. Some of the other observations can be listed as :

(1) Price : Economies of scale are a very important factor when shifting to solar power systems is concerned. An average Indian household is very conservative when new, innovative, and unconventional expenditure is to be done. To convince them about shifting to renewable energy resources is a huge challenge and requires a collaborative and cohesive taskforce including policy makers, manufacturers, marketers, and NGOs. Natarajan and Nalini (2015) in their study on social cost-benefit analysis of solar products inferred that despite having greater benefits over costs, solar power was not diffused to the extent it should have been owing to a high startup capital and steps are needed to reduce costs to make the products viable and popular. In the event of decreasing prices, newer, better, and cheaper technologies for storage systems, consumers especially, residential customers can be made aware of the relative advantages of solar energy over conventional electricity sources. It is well established that once the solar power prices fall below the grid tariffs (which are generally on the rise), a rooftop solar which is installed today will cost much cheaper than grid power since the solar PV systems generally, have an effective life span of 25 years with very little maintenance cost.

(2) Financial Assistance : It was observed that many people were ready to adopt the systems if they were given bank loans on very less interest rates. There were suggestions that banks should provide loans specifically for installation of high cost solar PV (photo voltaic) systems and solar water heaters. Some of the newer policy measures taken by central government include making roof top solar a part of housing loan provided by banks. Similarly, microfinance institutions and self help groups especially, organizations related to women welfare can

be helpful in increasing financial awareness. Short-term loans at smaller rate of interests and easy payback conditions may also help in increasing adoption rates among middle and low income groups.

(3) Promotion : Awareness campaigns by private manufacturers as well as related government departments should be carried out at different pockets of the city, wherein banks and other institutions can also provide on the spot financial assistance. Here, local radio and TV channels can also play an important role in persuading people to adopt solar products. Regular advertisements in print as well as other media like local radio stations increases the product recall rate. Visibility and trialabilty of solar products can be increased through visual aids, demonstrations at strategic locations like community shopping centres like Chhappan Dukan, Rajwada, Malls like C21, Treasure Island and Central, Vijay Nagar, Sapna Sangeeta, recreational parks like Meghdoot garden, and Regional Park. Along with demonstrations, governmental initiatives can also be highlighted at these places with the help of information stalls. This may become a part of government run Special Area Demonstration Project program under MNRE Government of India. More participation from manufacturers and dealers can also be anticipated so that individual share in adoption of solar products can be increased as depicted in the study by Dutta, Roy, and Su (2014) wherein, they concluded that sustainable industrialization was the need of the hour and corporates should focus on investments mainly in the fields of green, clean, and resource efficient technologies.

Limitations of the Study and Scope for Further Research

The study was carried out using convenience sampling method which may not have truly represented the total population of individual households of Indore. The demographics also fluctuated at different parts of the same city. Hence, this research can be widened by including the users of solar products, that is, individual households and institutional users as well, and with a bigger sample size. Further, the study may be improvised by taking opinion survey of developers and financial institutions on how to improve the solar ecosystem as a whole.

The purchasing patterns and consumer behavior regarding adoption of solar products can be studied given certain leverages like availability of financial assistance in the initial phases of purchase. A report by Mercom India dated may 14, 2018 highlighted that the subsidy disbursement delays were discouraging developers, installers, and contractors for rooftop solar installations in the domestic segment. Further, the study can be carried out to find ways to incorporate certain encouraging community solar energy systems which are helpful for apartment dwellers and people who reside in rented accommodations. The study can also be expanded to other areas of Madhya Pradesh and subsequently problem areas as well as the model areas can be identified and suggestions can be further provided to strategize the higher adoption rates of solar energy systems throughout the state.

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