Evaluation of Consumer Behaviour & Assessment of Factors Determining Acceptance of Solar Energy Products

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Abstract

Punjab is one of the largest energy consuming states in India, where people face the shortage of electricity. Punjab needs an alternative source of energy. However, still, the state has not adopted solar energy as an alternative source of energy. This paper attempted to assess the awareness level and identify the major barriers that limit the diffusion of solar energy products. An exploratory factor analysis was applied to discover the factors that determine acceptance of solar energy products. The survey was conducted in Punjab covering six cities. Descriptive analysis was done to evaluate the present status of solar energy awareness. The factor analysis revealed five factors that explained more than 60% of variance. Lack of financial support by government and high initial costs were identified as the major barriers that limit diffusion of solar energy products.

Keywords : **solar energy, new & renewable energy, consumer behaviour, barriers**

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Solar energy is created by the light and warmth of the sun in the pattern of electromagnetic radiation. In these days, using instruments, we are able to capture this radiation and turn it into working forms of solar energy - such as heating or electricity (Jingcheng, 2010). In case of solar energy, two elements are needed to deliver a functional solar energy generator. These two factors are a gatherer and a memory unit. The collector simply collects the radiation that falls on it and converts a fraction of it to other configurations of energy (either electricity and heat or heat only). The memory unit is involved because of the non-invariant nature of solar energy; at certain times, only a really modest sum of radiation will be received (Honsberg & Bowden, 2016).

Two major technologies have been evolved to harness solar energy : Photovoltaic solar technology, which directly converts sunlight into electricity using panels made of semiconductor cells and solar thermal technology, which captures the sun's heat. This warmth is employed directly or converted into mechanical energy, and in turn, electricity, known as concentrated solar power (Planete Energies, 2015). In the markets, competition is high, marketers will be successful when they identify, analyze, respond to the changing needs of the consumer (Juyal, 2013). Rural consumer behavior and the process of decision-making has acquired significant attention and there has been a rise in the importance of private corporate big giants as the rural consumer studies buying /consuming everything that is meant for the urban market (Prakash & Begum, 2016).

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Photovoltaic Solar Technology

Photovoltaic (PV) conversion is the direct conversion of sunlight into electricity without any heat engine to the interface. A photovoltaic power generation system consists of multiple components like cells, mechanical and electrical connections, and mountings and means of regulating and modifying the electrical output. These are rated in kilowatt (kW), which is a quantity of electrical power that a system is required to give up. All solar cells need a light absorbing material which is present inside the cell structure to absorb photons and generate free electrons via the photovoltaic effect (Parida, Iniyan, & Goic, 2011).

Status of Solar Energy

The world's energy demand is expected to increase by 35% by 2030 due to increase in population and economic growth. The world's total investment in solar technology is US $ 140.4 billion. Presently, the total global operating capacity of solar (PV) has reached the 100 gigawatt (GW) milestone. Its adoptions, run by Europe, are expanding to new markets of Africa and the Middle East, North Africa, Asia to Latin America. Interest in community owned and a self-generated system has been growing tremendously since 2012. Global solar thermal capacity reached an estimated 282GW and water collection by 255GW. China and Europe have captured 90% of the world market (UN Environment, 2013).

Solar energy is the energy derived from the sun in the form of radiation. India is endowed with rich solar energy resources. The average intensity of solar radiation received in India is 200MW/km with 250-300 sunny days in a year. Rajasthan receives the highest annual radiation energy and the North - Eastern regions of India receive the least (Sharma, Tiwari, & Sood, 2011). The India Energy Portal has estimated that around 12.5% of India's land mass, or 413,000 km^2, could be used for harnessing solar energy. India too holds the potential to significantly reduce electricity demand through increased deployment of solar water heaters (SWH), and India has over 17 GW of installed renewable power generating capacity with solar contributing only 15 MW (Kumar, Kumar, Kaushik, Sharma, & Mishra, 2010). India is one of the world leaders in installed renewable energy capability, with a total capacitance of 17,594 MW (utility and non-utility). MNRE sought to produce an attractive environment for investors, and including incentives such as feed-in tariff increased India's installed solar power capability to 15.2 MW at the end of June 2010. As of March 2014, India had 2631.9038 MW of grid connected solar power projects which were commissioned under Jawaharlal Nehru National Solar Mission (JNNSM) (Arora, Busche, Cowlin, Engelmeier, Jaritz, Milbrandt, & Wang, 2010).

To implement new solar energy polices effectively in Punjab, the government should install solar power plants and provide funding for independent research on solar energy (Kansal & Pathania, 2016). In order to improve installation, grid and off grid, a strong presence of the Internet and social mass media is necessary. For attracting more users, Ministry of New and Renewable Energy (MNRE) should focus on increasing participation in seminar awareness programs in different parts of India (Kansal & Pathania, 2015). Diffusion of innovation depends on the qualities of innovation, which are dependent on maximum return from investment and performance guarantee (Kansal & Pathania, 2014).

Literature Review

Greater reliance on solar power could boost the country's energy security and lessen its heavy dependence on coal. Cheaper solar power can help thousands of Indian homes to gain access to electricity for the first time (Dutta & Roy, 2014). States' tax credits and conventional energy costs significantly affect the probability of solar installation. SPV & solar home lighting systems in India are far below potential despite government subsidy programmes. Another major barrier is the high capital of investments required (Purohit & Michaelowa, 2008).

Consumer behavior of solar products is influenced by income and education (Mavuri, 2011). People who were more concerned about uncertainty were willing to pay more for shorter lease time (Shih & Chou, 2011). With product development, the economic, operational, and aesthetic aspects could be improved. For effectively spreading awareness of innovation, sensible marketing strategies should be utilized (Faiers & Neame, 2006). Environment, information, attitude, and motivation to compensate for renewable energy influence the adoption of solar energy (Bang, Ellinger, Hadjimarcou, & Traichal, 2000). Knowledge of users that fall in adapter category and users who are opinion leaders can help the companies to map the communication channels and can enhance the opportunities for successful diffusion (Harder, 2009).

Most of the leading technologies can significantly lower the module production costs (Razykov, Ferekides, Morel, Stefanakos, Ullal, & Upadhyaya, 2011). Solar photovoltaic (PV) energy has been an indefinite and clean energy with minimum harmful impact on the environment. India now moves forward with a common goal of protecting the environment. There could be a great experience for the future prospects of green marketing in India and the benefits and stability provided by the same to the society (Tara, Singh, & Kumar, 2015). In Malaysia, the implementation of solar energy faced the hurdles of high cost of PV & solar electricity tariff rate. Awareness created by mass media, active government policy, healthy competition, & new PV manufacturing should promote the future prospect of solar technology in Malaysia (Mekhilef, Safari, Mustaffa, Saidur, Omar, & Younis, 2012). The same steps can be adopted for promotion of solar energy in India.

Objectives of the Study

(1) To ascertain the awareness levels of non-user households regarding solar energy products.

(2) To identify the barriers limiting the use of solar energy in Punjab.

(3) To identify the factors that determine the acceptance of solar energy products in Punjab.

Methodology

The data were collected by using a survey questionnaire administered to the residents of Pathankot, Gurdaspur, Jalandhar, Kapurthala, Ludhiana, and Bathinda from Punjab and who were potential users of solar energy products. The survey was conducted between July-December 2015. A total of 300 respondents were selected from 10 distributors chosen each from city, followed by five respondents per distributor. The foremost requirement was that the respondents must be the citizens of Punjab. The second condition was that the participant must be the head of the household. The study scope is limited to urban participants only.

Analysis and Interpretation

Descriptive and inferential analysis techniques were applied for analyzing the data. To assess the awareness level of the respondents about renewable and non-renewable energy, percentage & line charts were used. To check whether awareness of respondents differed across demographic variables, independent one-way ANOVA was

Table 1. Knowledge of the Difference Between Renewable and Non - Renewable Energy Sources

S. No.	Response	Frequency	%
1.	Yes	262	87.4
2.	No	38	12.6

used. Furthermore, factor analysis was applied to identify the factors that determine the acceptance of solar energy products in Punjab.

The Table 1 shows that majority (87.4 %) of the respondents knew the difference between renewable and non-renewable sources of energy.

(1) Familiarity of Non-Users with Solar Energy Products : To test whether awareness of respondents differed across demographic variables, the following hypotheses are tested :

- **$H_0$1:** Familiarity of non-users with solar energy products does not differ significantly across cities.
- **$H_0$2:** Familiarity of non-users with solar energy products does not differ significantly between educational qualification.
- **$H_0$3 :** Familiarity of non-users with solar energy products does not differ significantly between occupation.
- **$H_0$4 :** Familiarity of non-users with solar energy products does not differ significantly between income level.

The Figure 1 depicts city wise familiarity of non-users with solar products. Non-users from Kapurthala showed highest familiarity (3.10) followed by users in Gurdaspur (3.00) and Bathinda (2.86). Non-users from Pathankot (2.55) were found to have relatively least familiarity with solar products, followed by users in Jalandhar (2.56) and Ludhiana (2.63). To test whether the familiarity of non-users differed significantly across cities, one-way independent ANOVA was performed and the results are shown in the Table 2.

Figure 1. City Wise Familiarity of Non-Users with Solar Energy Products

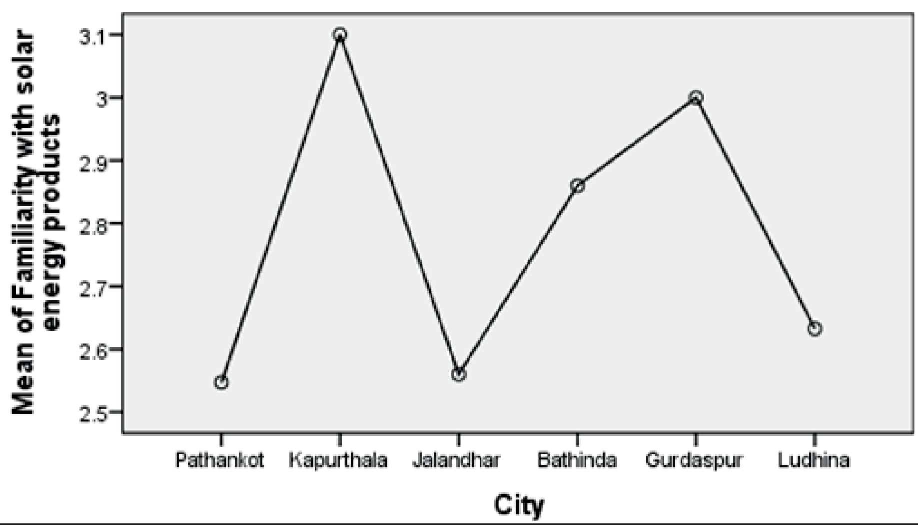

Table 2. Descriptive Statistics and ANOVA Results for Familiarity of Non-Users with Solar Energy Products

Hypothesis	Lev. Stat.	Sig.	*F*	Sig.
$H_0$1 (Cities)	3.955	.002	3.695 (W) 3.4956 (B)	.004 .004
$H_0$2 (Education)	2.293	.103	.932	.395
$H_0$3 (Occupation)	.508	.677	1.982	.117
$H_0$4 (Income)	2.559	.055	1.865	.136

Figure 2. Educational Qualification Wise Familiarity of Non-Users with Solar Energy Products

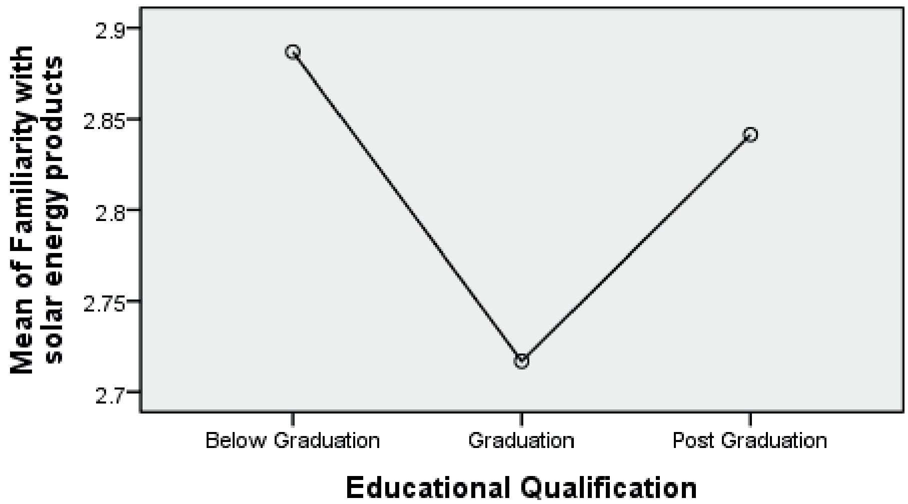

Figure 3. Occupation Wise Familiarity of Non-Users with Solar Energy Products

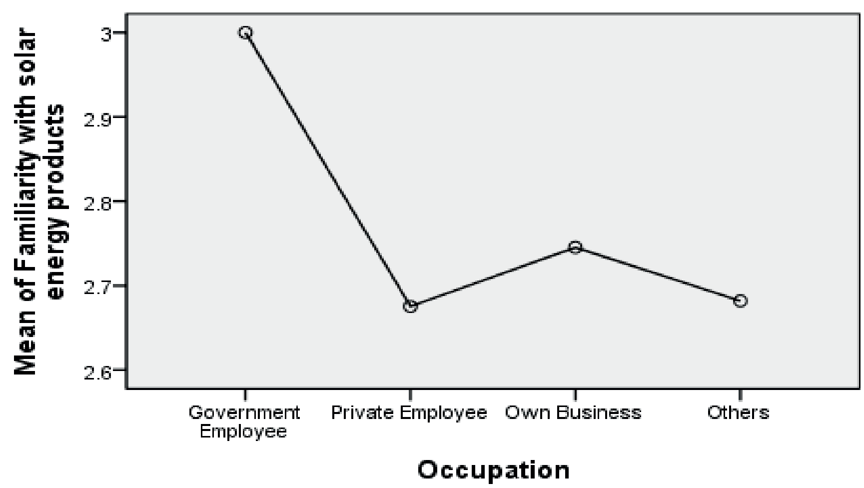

Figure 4. Income Wise Familiarity of Non-Users with Solar Energy Products

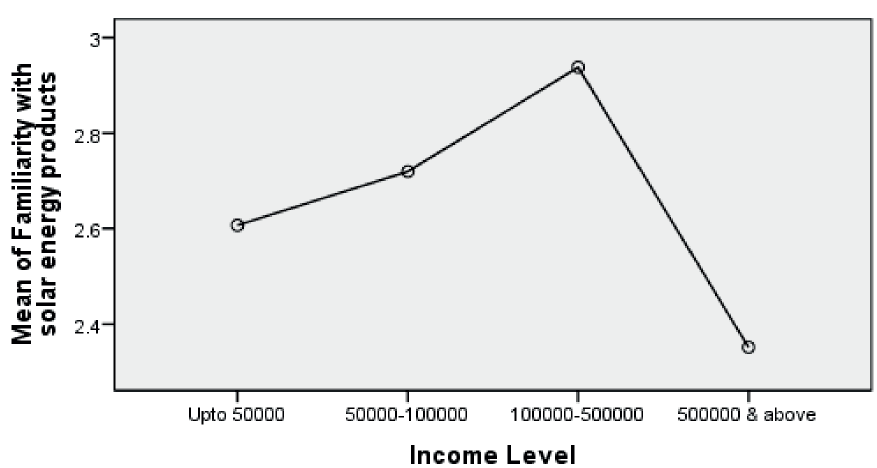

Table 3. Post Hoc Contrasts (Games-Howell) for the Differences in the Familiarity of Non-Users with Solar Energy Products Across Cities

City	City	Mean Difference	Sig.
Pathankot	Kapurthala	**-.553**	**.028**
	Jalandhar	-.013	1.000
	Bathinda	-.313	.596
	Gurdaspur	-.453	.058
	Ludhiana	-.085	.996
Kapurthala	Jalandhar	**.540**	**.046**
	Bathinda	.240	.843
	Gurdaspur	.100	.991
	Ludhiana	.467	.100
Jalandhar	Bathinda	-.300	.667
	Gurdaspur	-.440	.095
	Ludhiana	-.073	.998
Bathinda	Gurdaspur	-.140	.975
	Ludhiana	.227	.851
Gurdaspur	Ludhiana	.367	.200

The Figure 2 displays the educational qualification wise familiarity of non-users with solar products. Non-users with below graduation educational qualification showed highest familiarity (2.89) followed by post-graduate non-users (2.84) and graduate non-users (2.272). To test whether the familiarity of non-users differed significantly between their educational qualification, one-way independent ANOVA was performed and the results are shown in the Table 2.

The Figure 3 shows occupation wise familiarity of non-users with solar energy products. Government employees showed highest familiarity (3.0) followed by own business (2.75), private employees (2.68), and retired persons (2.68). To test whether the familiarity of these non-users differed significantly between their occupations, one-way independent ANOVA was performed and the results are shown in the Table 2.

The Figure 4 shows income wise (annual income) familiarity of non-users with solar products. Non-users with income between ₹ 1,00,000 - ₹ 5,00,000 were found to have higher familiarity (2.91) followed by respondents with income up to ₹ 50,000 - ₹ 1,00,000 (2.70) and respondents with up to ₹ 50,000 income (2.61). Non-users with above ₹ 5,00,000 income were found to have relatively low familiarity (2.63) with solar products. To test whether the familiarity of non-users differs significantly between their income levels, one-way independent ANOVA was performed and the results are shown in the Table 2.

To test the homogeneity of variance among groups, Levene test was performed. Levene test results are non-significant as $p > .05$ for hypotheses $H_0 2$, $H_0 3$, and $H_0 4$, which means that variances among groups are equal, therefore, one-way ANOVA was applied to compare the groups. For hypothesis $H_0 1$, the Levene test result is significant as $p < .05$, which means that variances among groups are not equal, therefore, Welch and Brown-Forsythe ANOVA was applied to compare the groups. ANOVA results for hypothesis $H_0 1$ show that familiarity of non-users with solar energy based products differs significantly across cities, so the null hypothesis $H_0 1$ is rejected [F (5, 137.333) = 3.695, $p < .05$]. ANOVA results for hypothesis $H_0 2$ show that familiarity of non-users with solar energy based products do not differ significantly between educational qualification, so the null hypothesis $H_0 2$ is accepted [F (2, 298) =. 932, $p > .05$]. ANOVA results for hypothesis $H_0 3$ show that familiarity of non-users with solar energy based products does not differ significantly between occupations, so the null hypothesis $H_0 3$ is

Table 4. Barriers Limiting the Diffusion of Solar Energy

S. No.	Barriers	Yes	No	Yes %
1.	Lack of financial support by the government.	190	110	63.1
2.	Lack of promotion by the government.	144	156	47.8
3.	Special installation requirements.	118	182	39.2
4.	Technical complexities.	108	192	35.9
5.	The threat of poor quality products sold in the market.	118	182	39.2
6.	Lack of research and testing by firms.	103	197	34.2
7.	Inadequate standards.	92	208	30.6
8.	Long payback period.	102	198	33.9
9.	Cost involved in changing battery periodically.	116	184	38.5
10.	Higher maintenance and repair cost.	123	177	40.9
11.	Higher initial cost as compared to conventional sources.	160	140	53.2

Table 5. Solar Products Preferred by Non-Users to Use at Home in the Future

S. No.	Solar Products	Yes	No	Yes %
1.	Solar Charger	44	256	14.6
2.	Solar Calculator	59	241	19.6
3.	Solar Cooker	118	182	39.2
4.	Solar Dryer	56	244	18.6
5.	Solar Fan	104	196	34.6
6.	Solar Inverter	116	184	38.5
7.	Solar Lamp	103	197	34.2
8.	Solar Water Heater	84	216	27.9
9.	Solar Power Watch	49	251	16.3
10.	Solar Water Pump	33	267	11.0
11.	Solar Light	115	185	38.2
12.	Solar Cap	106	194	35.2
13.	Solar Scooter	2	298	0.7
14.	Solar Air Conditioner	9	291	3.0
15.	Solar Tractor	1	299	0.3
16.	Solar Machines	5	295	1.7
17.	Solar Agricultural Equipment	1	299	0.3
18.	Solar Car	25	275	8.3
19.	Solar Television	11	289	3.7
20.	Solar Speakers	1	299	0.3
21.	Solar Induction	2	298	0.7
22.	Solar Microwave	15	285	5.0
23.	Solar Geyser	8	292	2.7
24.	Solar Phone	7	293	2.3
25.	Solar Battery	2	298	0.7
26.	Solar Torch	1	299	0.3
27.	Solar Tube Well	1	299	0.3

accepted [$F(3, 297) = 1.982, p > .05$]. ANOVA results for hypothesis H_04 show that familiarity of non-users with solar energy based products does not differ significantly between income levels, so the null hypothesis H_04 is accepted [$F(2, 288) = 1.865, p > .05$].

The Table 3 shows individual comparisons of cities with each other calculated through the Games-Howell method. Results of the test depict that familiarity of non-users of Kapurthala is significantly higher from the familiarity of non-users of Jalandhar and Pathankot with $p < .05$.

The Table 4 shows that lack of financial support by the government (63.1%) and high initial costs (53.2%) are the major barriers that limit the diffusion of solar energy followed by lack of promotion by the government (47.8%), high maintenance and repair cost (40.9%), special installation requirements (39.2%), threat of poor quality products sold in the market (39.2%), and cost involved in changing the battery periodically (38.5%). Inadequate standards (30.6%) were the least influencing diffusion barrier followed by a long payback period (33.9%), lack of research and testing by firms (34.2%), and technical complexities (35.9%).

The Table 5 shows various solar products which non-users would prefer to use in their homes in the future. More than 30% of the non-users opined that they would prefer to use solar cooker, solar light, solar cap, solar inverter, solar fan, and solar lamp ; 27.9% of the respondents said that they would prefer to use solar water heater, 19.6% showed preference for solar calculator, 18.6% showed preference for solar dryer, 16.3% preferred solar power watch, 14.6% preferred solar charger, and 11 % preferred solar water pump. All other solar products were preferred by less than 10% of the non-users.

(2) Factors Determining Non-Users' Behaviour Towards Solar Energy Products : To identify the factors determining non-users' behavior towards solar energy products, 19 statements/items were taken for analysis. Factor analysis (exploratory) was employed on statements measured on a 5 - point scale (*strongly disagree - strongly agree*) to identify factors determining the non - users' behavior towards solar energy products. The Table 6 shows the values of Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity. Kaiser-Meyer-Olkin measure of sampling adequacy is a measure to quantify the degree of inter-correlations among the variables, and the appropriateness of factor analysis is the measure of sampling adequacy (MSA). This measure varies between 0 and 1, and values closer to 1 are better.

The value of KMO is 0.77, which is meritorious (Hair, Anderson, Babin, & Black, 2010). Bartlett's test of sphericity is significant, which provides the statistical significance that the correlation matrix has significant correlations among at least some of the variables (Hair et al., 2010).

The scree plot in Figure 5 shows the distribution of variance among the components graphically. The variance of each component is less than the preceding one. The curve shows an "elbow" at a given value on the x-axis, this is often taken as indicating that higher order principal components contribute a decreasing amount of additional variance and so might not be needed (Landau & Everitt, 2004). The scree plot shows a marked decrease in downward slope after the fifth principal component, implying that we can summarize our 19 items by five principal components. However, factors were extracted on the basis of latent root criterion (i.e. Eigen value > 1).

The Table 7 depicts the results of principal component analysis after varimax rotation, Eigen values, the percentage of variance, and cumulative percentage of total variance extracted by successive factors. Principal component analysis was employed for extracting the factors based on latent root criterion (i.e. Eigen value > 1) for

Table 6. KMO and Bartlett's Test of Sphericity

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.772
	Approx. Chi-Square	2838.983
Bartlett's Test of Sphericity	*Df*	153
	Sig.	.000

Figure 5. Scree Plot for the Statements Related to Factors Determining Non-Users' Behavior Towards Solar Energy

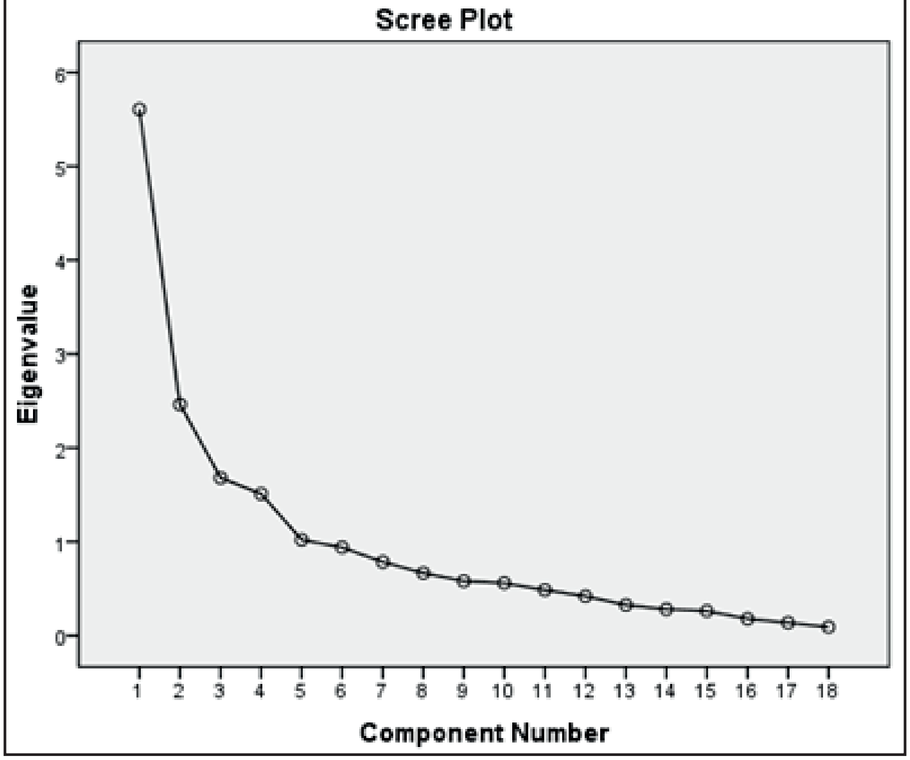

Table 7. Principal Component Analysis with Varimax Rotation for the Statements Related to Non-Users' Behavior Towards Solar Energy

S.No.	Statements/Items	Factors 1	2	3	4	5	Communalities
(1)	Solar power can generate electricity no matter how remote the area as long as the sun shines there.	**.876**	-.022	.039	.136	.166	.816
(2)	Solar energy is the best alternative to conventional energy as India suffers from acute power shortages.	**.863**	.005	.043	.113	.142	.780
(3)	The generation of electricity through solar power produces no noise.	**.814**	.225	.239	.099	.011	.780
(4)	The quality of supply from solar technology is quite reliable.	**.808**	.204	.249	.099	.057	.770
(5)	Solar energy is effective and is proven to reduce a percentage of greenhouse gas emissions.	**.605**	-.271	.015	.053	.325	.548
(6)	It is important for the use of solar technology resources to be listed among environmental protection activities.	.055	**.826**	.021	.014	.063	.690
(7)	I am willing to set up a solar technology product if provided a loan at an attractive interest rate in addition to government subsidy.	-.005	**.798**	-.017	.059	.056	.644
(8)	Producing energy from renewable energy resources such as the Sun is an excellent idea.	.058	**.723**	.408	.216	-.039	.741
(9)	I am aware of the harmful effects of fossil fuels like coal and petroleum.	.101	-.036	**.846**	.073	.199	.773
(10)	Benefits related to the use of solar technology resources are well known to me.	.265	.141	**.687**	.156	.382	.732

(Table contd. on next page)

(11)	Solar technology resources is the other name of clean energy resources.	.175	.477	**.601**	.190	.062	.659
(12)	Investment should be increased in R & D to improve the technology of solar technology resources.	.203	.089	.145	**.776**	.167	.700
(13)	Public investments should be increased in order to make effective and rational use of solar technology.	.229	.150	.314	**.749**	-.117	.748
(14)	Credit facilities should be provided by banks for the installation of solar technology.	-.092	-.047	-.145	**.704**	.288	.610
(15)	More financial schemes should be offered for increasing the usage of solar technology.	.270	.265	.237	**.551**	-.293	.589
(16)	Media provides required information on solar technology resources.	.178	.079	.045	-.011	**.767**	.629
(17)	There is a need for a considerable shift in the mindset of the people from conventional sources of energy to solar energy.	.155	-.095	.286	.237	**.630**	.55
(18)	Education on solar technology resources should be made a part of curriculum.	.109	.252	.362	.065	**.621**	.596
	Total	**3.553**	**2.439**	**2.204**	**2.155**	**1.936**	
	% of Variance	**19.74**	**13.55**	**12.24**	**11.97**	**10.75**	
	Cumulative %	**19.74**	**33.29**	**45.53**	**57.50**	**68.26**	

the number of factors to be extracted. An Eigen value of 1.00 is the most commonly used criterion for deciding how many factors to retain in factor reduction (Cattell, 1966 ; Stevens, 1996).

The derived factors explain 68.26% of the total variance, which is above the minimum limit of 60% in social sciences (Hair et al., 2010). The percentages of variance extracted by Factors 1 to 5 are 19.74%, 13.55%, 12.24%, 11.97%, and 10.75%, respectively. The last column of the table shows values of communalities corresponding to each item. Communalities explain the amount of variance in a variable that is accounted for by the all the factors taken together. All of the communalities were ensured to exceed the value of 0.50 before performing the rotation of the factor matrix (Hair et al., 2010). Item number 6 was deleted due to communality value less than 0.50.

Rotated Factor 1 seems almost exclusively associated with variables 13, 9, 12, 8, and 11, and the Factor 1 is named as Benefits (of solar energy). Rotated Factor 2 appears most closely associated with variables 15, 19, and 10, and is named as Attitude (towards solar energy). Rotated Factor 3 appears most closely linked with variables 5, 1, and 7, and the variable is named as Awareness (about solar energy). Rotated Factor 4 seems associated with variables 16, 14, 17, and 18, and the factor is named as Investment (required in solar energy). Rotated Factor 5 seems almost exclusively associated with variables 2, 4, and 3, and the factor is named as Promotion (of solar energy). All the items load highly with their respective factors, and loading is considered to be "large" if its absolute value exceeds .40 (O'Rourke& Hatcher, 2013).

➭ **Reliability of Factors :** Reliability refers to the extent to which a scale produces consistent results if repeated measurements are made. Internal consistency reliability is used to assess the reliability of a summated scale, where several items are summed to form a total score. In a scale of this type, each item measures some aspect of the construct measured by the entire scale, and the items should be consistent in what they indicate about the construct. The Table 8 displays the coefficient alpha, or Cronbach's alpha.

Cronbach's alpha measures the inter consistency reliabiltity and it is the average of all possible split-half coefficients resulting from different ways of splitting the scale items. This coefficient varies from 0 to 1, and a value of 0.6 or less generally indicates unsatisfactory internal consistency reliability (Malhotra, 2008). Cronbach's alpha is the most widely used measure of internal consistency. The generally agreed upon lower limit for Cronbach's alpha is .70, although it may decrease to 0.60 in exploratory research (Hair et al., 2010). Reliability

Table 8. Cronbach's Alpha Reliability Scores of Factors

Factor No.	Factor Name	Item No.	Statements/Items	Factor Loading	Cronbach's Alpha Reliability
F1	BENEFITS	13	Solar power can generate electricity no matter how remote the area as long as the sun shines there.	.876	**.883**
		9	Solar energy is the best alternative to conventional energy as India suffers from acute power shortages.	.863	
		12	The generation of electricity through solar power produces no noise.	.814	
		8	The quality of supply from solar technology is quite reliable.	.808	
		11	Solar energy is effective and is proven to reduce a percentage of greenhouse gas emissions.	.605	
F2	ATTITUDE	15	It is important for the use of solar technology resources to be listed among environmental protection activities.	.826	**.759**
		19	I am willing to set up a solar technology product if provided a loan at an attractive interest rate in addition to government subsidy.	.798	
		10	Producing energy from energy resources such as the Sun is an excellent idea.	.723	
F3	AWARENESS	5	I am aware of the harmful effects of fossil fuels like coal and petroleum.	.846	**.757**
		1	Benefits related to the use of solar technology resources are well known to me.	.687	
		7	Solar technology resources is the other name of clean energy resources.	.601	
F4	INVESTMENT	16	Investments should be increased in R & D to improve the technology of solar technology resources.	.776	**.732**
		14	Public investments should be increased in order to make effective and rational use of solar technology.	.749	
		17	Credit facilities should be provided by banks for the installation of solar technology.	.704	
		18	More financial schemes should be offered for increasing the usage of solar technology.	.551	
F5	PROMOTION	2	Media provides required information on solar technology resources.	.767	**.654**
		4	There is a need for a considerable shift in the mindset of people from conventional sources of energy to solar energy.	.630	
		3	Education on solar technology resources should be made a part of curriculum.	.621	

value for all factors, as shown in the Table 8, varies from 0.65 to 0.88. Therefore, all the identified factors show an acceptable level of reliability scores for factors.

Discussion and Conclusion

Various places in India still face acute electricity shortage. Our country needs massive additions in capacity to meet the demand of its rapidly growing economy. Solar energy development in India can also be an important tool for spurring regional economic development. But still, we have not adopted solar energy as an alternative source of energy. The study observes that the majority of the non-users were aware about the differences between renewable and non-renewable sources of energy. Familiarity of non-users with solar energy differed significantly across educational qualifications, occupations, and income levels. However, the geographical location of the respondents significantly determined their awareness level about solar energy products as the non-users of Kapurthala city showed significantly high level of familiarity as compared to the non-users of Pathankot and Jalandhar.

Lack of financial support and promotion by the government and high initial costs are the major barriers that limit the diffusion of solar energy products. Research by Purohit and Michaelowa (2008) supported that high capital investment is the major barrier in diffusion of solar energy products. A study of energy policies to promote renewable energy technologies, learning from Asian countries' experiences also revealed that renewable energy production cost is still higher than other conventional energy sources and the government's incentives in R&D sector can promote innovation in this area and consequently, cost reduction will occur in the renewable energy market (Shokri & Heo, 2011). A study by Shukla, Ghosh, Debyani, Ramana, and Garg (2008) pointed out that despite the cost reductions achieved over recent years, the largest barrier to greater renewable energy use is its high cost.

The barrier of high capital investment was also pointed out by one-third of the non-users as they reported that they would prefer to use solar cooker, solar light, solar cap, solar inverter, solar fan, and solar lamp in the future. Five factors were identified through exploratory factor analysis that determined non-users' behavior towards solar energy products. On the basis of the nature of items in a factor, these factors are named as Benefits (of solar energy), Attitude (towards solar energy), Awareness (about solar energy), Investment (required in solar energy), and Promotion (of solar energy).

Implications

There is a significant need to overcome the barriers that limit the diffusion of solar energy. Presently, the initial cost of installation of solar energy products is significantly higher than it is for other conventional sources of energy. Therefore, to create demand of solar energy products, the government should provide high subsidies on these products. Once, the demand increases, subsidies may be withdrawn in stages, as the benefits of higher economies of scale will help manufacturers of solar products to reduce the product prices. Although many Central and State government subsidy schemes are in place, but still, people feel that more financial support from the government is needed. This may be due to two reasons; first, the subsidized cost is still higher than people's expectations. Second, the benefits of subsidies may not be properly passed to the consumers. Therefore, the government needs to investigate the actual reasons of expected financial support.

Another important barrier is lack of promotion by the government. The government should increase the outreach of its advertisements of solar energy products and provided subsidies. It should be ensured that all the geographical areas are equally aware of present installation process & cost of solar energy products, as well as the available government subsidies. Additionally, effective R&D is required to bring down the cost of solar energy products.

Limitations of the Study and Scope for Further Research

The present study is limited to Punjab state only. Therefore, the findings and implications may be limited to the geographical size, location of the population, socio - culture and economic differences in the region. For the generalization of the results of the present study outside Punjab, the study may be replicated at national and worldwide levels.

Only exploratory factor analysis was applied to identify the factors, and further research could reveal relative importance and point out the significant factors that influence non-users' behavior towards solar energy products. A comparative analysis may be conducted between two and more states of India to assess the cross validity of the results of the present study. Moreover, a structural model may be constructed after a thorough review of the relationships between the identified factors.

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