Study of Familiarity, Satisfaction & Motives of Users for using Solar Energy Based Products in Punjab

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Abstract: In Punjab electrification through Solar system is becoming more popular. It Presents and attractive alternative to conventional electricity, such as no monthly bills, no fuel cost, little repair & maintenance costs easy to install anywhere etc. Solar energy Product has already made significant headway in Punjab. But commercial success of solar of solar energy products in Punjab depends on the extent to which it can attain the end users satisfied. Which will prompt users to invest money in solar energy & make long –term relationship with service Provider? In the consideration the present study made an endeavor to evaluate the customer familiarity, satisfaction & motive of the solar energy products by adopting the ANOVA as the bases of conducting the inquiry. A Total of 300 users from three areas of Punjab Maza Doaba Malwa. Two cities from each region. Pathankot & Gurdaspur from Maza Region, Jalandhar & Kapurthala in Doaba Region, Ludhiana & Bathinda from Malwa Region. From Study it has been set up that there is a significant deviation between the city in familiarity & Satisfaction of products. No power cut is the major motivator for using solar energy products. It can suggest guidelines for Manufacturing & Government for making Policy of for the future chances of solar energy Products in Punjab.

Keywords: *Familiarity, Solar energy, Photovoltaic, Satisfaction, semiconductor*

I. Introduction

Solar energy is created by light and warmth which is let out by the sun, in the pattern of electromagnetic radiation. In these days' tools, we are able to capture this radiation and turn it into working forms of solar energy - such as heating or electricity [1]. Referable to the nature of solar energy, two elements are taken 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 passion 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 [2] Two major technologies have been evolved to harness it: Photovoltaic solar technology, which directly converts sunlight into electricity using panels made of semiconductor cells. 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 [3].

Photovoltaic Solar technology

Photovoltaic 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 connection and mountings and means of regulating and modifying the electrical output. These organizations are rated in kilowatt (kW). which is a quantity of electrical power that a system is required to give up. When the sunlight is directly overhead on a light day. All solar cells needed a light absorbing material which is present inside the cell structure to absorb photons and generate free electrons via the photovoltaic effect [4].

Solar Thermal Technology

Solar Thermal Power systems, too known as concentrating solar power systems use concentrating solar collectors or generated heat is applied. The hot thermal fluid is applied to generated steam or hot gasses. which are then applied to run a heat engine. In the system, the efficiency of the collectors reduced marginally as its operating temperature increases, where the efficiency of a heat engine increases with the growth in operating temperature [5].

Solar India report

The India Energy Portal estimates that around 12.5% of India's land mass, or 413,000 km2, 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), India has over 17 GW of installed renewable power generating capacity with solar contributing only 15 MW [6]. India was one of the world leaders in installed renewable energy capability, with a total capacitance of 17,594 MW (utility and non-utility), MNRE seeks to produce an attractive environment for investors, including incentives such as feed-in tariff India's installed solar power capability of 15.2 MW at the end of June 2010. As of march 2014 India had 2631.9038MW of grid connected solar power projects which were commissioned under Jawaharlal Nehru National Solar Mission (JNNSM). [7].

Solar energy status in Punjab

Solar Punjab receives an estimated 4-7 units/m2 of solar insolation levels, suggesting that it has the high potential for solar power. Punjab government is targeting solar power generation of 1,000 MW by 2017 and is targeting to operationalize 500 MW solar power projects by March 2016. It has currently operational Zed 117 MW of solar power projects [8]. Punjab floated a tender in December 2014 for the second phase of allocations in the state for 250 MW of solar PV projects. Tasks were divided into three categories: category one was for a sum of 50 MW with project sizes between 1 MW and 4 MW, category two were for 100 MW with project sizes between 5 MW and 24 MW and category three was for 100 MW with project sizes between 25 MW and 100 MW. It was observed that developers preferred larger projects (as category three projects were heavily oversubscribed) with comparatively lower transaction prices and more alternatives for financial engineering [9].

II. LITERATURE REVIEW

The demand for effective education campaigns has substantial event on the probabilities of acceptance (Islam & Meade 2013)[10]. JNNSM has been a key driving factor behind solar energy development in India(Shrimali & Nekkalapudi 2014) [11] . The extensive application of solar energy in rural areas has positive social & Health effect. (Limao 2012) [12]. The NGOs also Provided financial management & technical aid to Implement the solar Project (Phatonova 2011)[13] .

Consumer behviour of solar products & Influence of income & education on buying solar products (Mavuri 2011). People who were more concerned about uncertainty were willng to pay more for a shorter lease time (Shih & Chou 2011) [14] .

Anuual worth of electric water heater becomes better than year on year cost of SWHS((Ali et al 2009)[15]. Confirm the gap in understanding, perception & reality & further action from policy level may be imitated to secure the positive result of SHS (Rahman & Ahmad 2013)[16]. . The finance, operations & invention aspects of product development would improve marketing strategies which spread awareness, improve observablity & Potential & Solar Technology (Faiens & Neame 2005) [17].

Environment, Information, attitude & motivation to compensate for renewable energy. (Ellinger et. al 2000) [18] . Presvation & Environmental are also considerable at the time Purchasing (Zhai & William) [19]. State tax Credit & Conventional energy cost significantly affect the probability of solar installation (Durham et al 1988) [20]. Mass Media, Strong government Policy, healthy competition & new PV manufacture should promote for future Prospect of solar technology (Mekhifiel et al 2012)[21].

Objective

1) To determine the Users Familiarity with Solar Energy based Products in Punjab.
2) To Study the Satisfaction of users from use of solar Energy based Products in Punjab.
3) To Study the Motives for using Solar Energy based Products in Punjab.

Research Methodology

This work uses both primary and secondary data in the investigation. By going through a study method, the responses from the ground were considered as the master data. Data was collected by passing out the survey questionnaires to residents of Pathankot, Gurdaspur, Jalandhar, Kapurthala, Ludhiana, Bathinda their survey was conducted between July 2015 to December 2015. The Primary data was gathered through a non-disguised structured questionnaire was administrated to 620 respondents. A sample of 310 users & 310 non-users were drawn through cluster sampling techniques. Equal number of respondents were drawn through cluster sampling techniques. Equal number of respondents were selected from each city. In case of Incomplete response, respondents were contacted again. Finally, 300 completed questionnaires were analysis

USERS FAMILIARITY WITH SOLAR ENERGY PRODUCTS

$H_0$1: *Familiarity of users with solar energy products do not differ significantly across cities.*

$H_0$2: *Familiarity of users with solar energy products do not differ significantly between educational qualification.*

$H_0$3: *Familiarity of users with solar energy products do not differ significantly between occupation.*

$H_0$4: *Familiarity of users with solar energy products do not differ significantly between income level.*

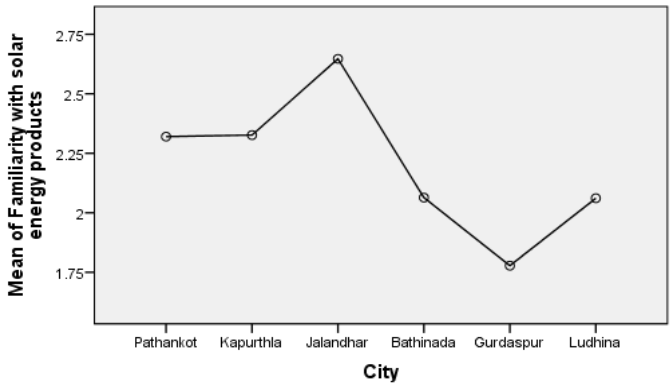

Fig1: City wise familiarity of users with solar energy products

Figure 1 depicts city wise familiarity of users with solar product. Users from Jalandhar showed highest familiarity (2.65) followed by Kapurthala (2.33) and Pathankot (2.32). Users from Gurdaspur (1.78) reported to have relatively least

familiarity with solar products followed by Bathinda and Ludhiana. To test whether the familiarity of users differ significantly across cities one-way independent ANOVA was performed and the results are shown in table 1.

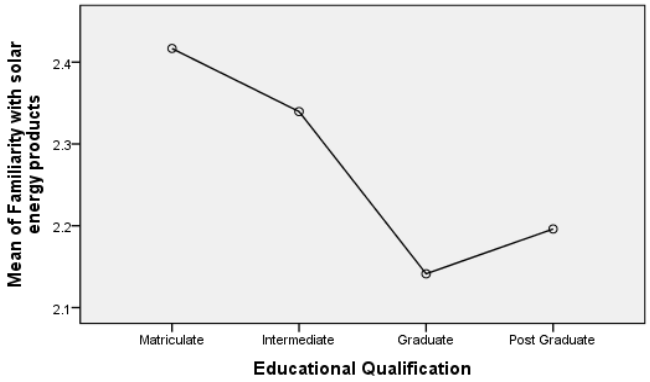

Fig 2: Education qualification wise familiarity of users with solar energy products

Figure 2 displays educational qualification wise familiarity of users with solar product. Matriculate users showed highest familiarity (2.42) followed by intermediate (2.34) and post-graduate (2.20). Graduate users (2.14) reported to have relatively least familiarity with solar products. To test whether the familiarity of users differ significantly between their educational qualification, one-way independent ANOVA was performed and the results are shown in table5.2.1.

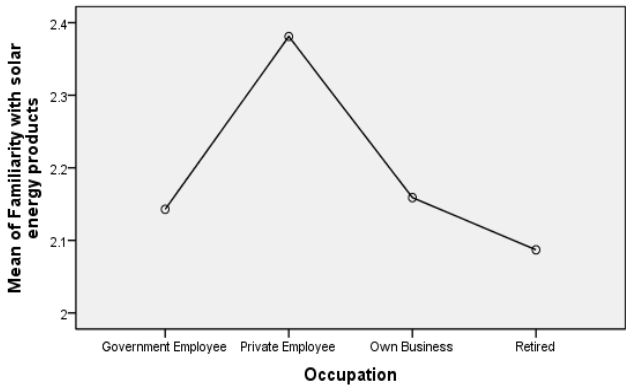

Fig 3: Occupation wise familiarity of users with solar energy products

Figure 3 shows occupation wise familiarity of users with solar product. Private employed users showed highest familiarity (2.38) followed by own business (2.16) and government employees (2.14). Retired users (2.09) reported to have relatively least familiarity with solar products. To test whether the familiarity of users differ significantly between their occupations, one-way independent ANOVA was performed and the results are shown in table5.2.1.

Figure 4 shows income wise familiarity of users with solar product. highest familiarity (2.24) followed by up to 50,000 income group (2.21). Users that belongs to above 50,000-1,00,000 income group reported to have relatively least familiarity with solar products. To test whether the familiarity of users differ significantly between their income levels, one-way independent ANOVA was performed and the results are shown in table 5.2.1.

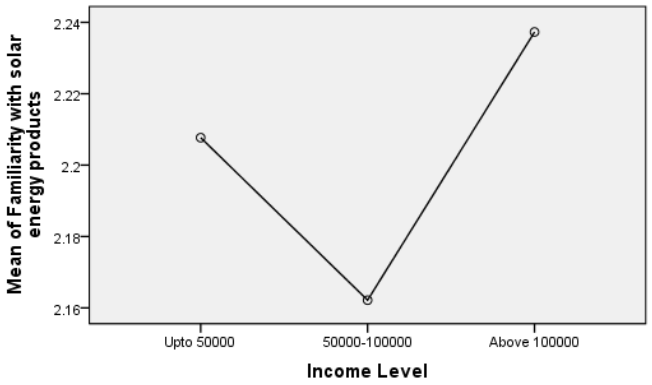

Fig 4: Income wise familiarity of users with solar energy products

Table I. Descriptive statistics and ANOVA results for familiarity of users with solar energy products

Hypothesis	Lev. Stat.	Sig.	F	Sig.
$H_0$1 (Cities)	7.694	.000	8.877 (W) 8.623 (B)	.000 .000
$H_0$2 (Education)	1.135	.335	1.227	.300
$H_0$3 (Occupation)	1.032	.379	1.555	.201
$H_0$4 (Income)	0.200	.819	.201	.818

To test homogeneity of variance among groups levene test was performed. Levene test results are non-significant, $P > .05$, which means that variances among groups are equal, therefore, one-way ANOVA was applied to compare groups for hypotheses $H_0$2 $H_0$3 and $H_0$4. For hypothesis $H_0$1 Levene test result is significant, $P < .05$, which means that variances among groups are not equal, therefore, Welch and Brown-Forsythe ANOVA was applied to compare groups for hypotheses $H_0$1. ANOVA results for hypothesis $H_0$1shows that familiarity of users with solar energy based products differ significantly between cities, so the null hypothesis $H_0$1 is rejected, $F (5, 135.139) = .8.877$, $P < .05$.ANOVA results for hypothesis $H_0$2shows that familiarity of users with solar energy based products do not differ significantly between educational qualification, so the null hypothesis $H_0$2 is accepted, $F (3, 296) = 1.227$, $P > .05$.ANOVA results for hypothesis $H_0$3shows that familiarity of users with solar energy based products do not differ significantly between occupations, so the null hypothesis $H_0$3 is accepted, $F (3, 296) = 1.555$, $P > .05$.ANOVA results for

hypothesis $H_0$4shows that familiarity of users with solar energy based products do not differ significantly between income levels, so the null hypothesis $H_0$4 is accepted, F (2, 297) = .201, P < .05.

Table 2.Post Hoc contrasts (Games-Howell) for familiarity of users with solar energy products.

Factors	(Age	Mean Difference	Sig.
Pathankot	Kapurthala	-.007	1.000
	Jalandhar	-.327	.280
	Bathinda	.256	.620
	Gurdaspur	.542	.013
	Ludhiana	.259	.393
Kapurthala	Jalandhar	-.321	.274
	Bathinda	.263	.571
	Gurdaspur	.549	.009
	Ludhiana	.265	.328
Jalandhar	Bathinda	.583	.002
	Gurdaspur	.869	.000
	Ludhiana	.586	.000
Bathinda	Gurdaspur	.286	.442
	Ludhiana	.003	1.000
Gurdaspur	Ludhiana	-.283	.212

Table 2 shows individual comparisons of cities with each other calculated through Games-Howell method. Results of test depicts that familiarity of users of Gurdaspur were significantly lower than from familiarity of users of Pathankot, Kapurthala and Jalandhar with solar energy products, p < 0.05. Familiarity of users of Jalandhar were significantly higher than from familiarity of users of Ludhiana with solar energy products, p < 0.05.

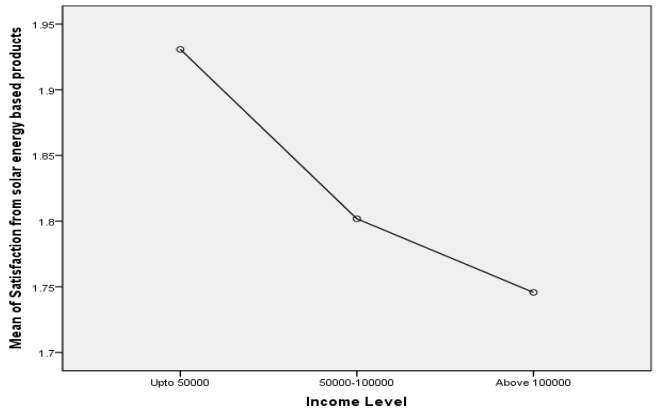

Fig 5: Satisfaction of users from use of solar energy based products

$H_0$5: *Satisfaction of users from use of solar energy based products do not differ significantly across cities.*

One-way independent ANOVA was performed to test the hypothesis that satisfaction of users from use of solar energy based products do not differ significantly across cities. The results of the test have been given in table 5.10.1 and table 5.10.2and figure 5.10.1 respectively.

Table 3: Descriptive statistics and ANOVA results for Satisfaction from solar energy based products across cities.

Statements	N	Mean	S.D	Lev. Stat.	Sig.	F	Sig.
Pathankot	50	1.86	.606	2.719	.020	3.200 (W)	.009
Kapurthala	49	2.02	.595			3.121 (B)	.009
Jalandhar	51	1.90	.640				
Bathinda	47	1.72	.649				
Gurdaspur	54	1.69	.609				
Ludhiana	49	2.06	.556				
Total	300	1.87	.621				

To test homogeneity of variance among group of cities levene test was performed. Levene test is significant,P < .05, which means that variances among groups are not same, therefore, robust tests of equality of means (Welch and Brown-Forsythe) were used to compare groups. Results shows thatsatisfaction of users from use of solar energy based products differ significantly across cities, so the null hypothesis is rejected, F (5, 136.765) = 3.200, P < .05.

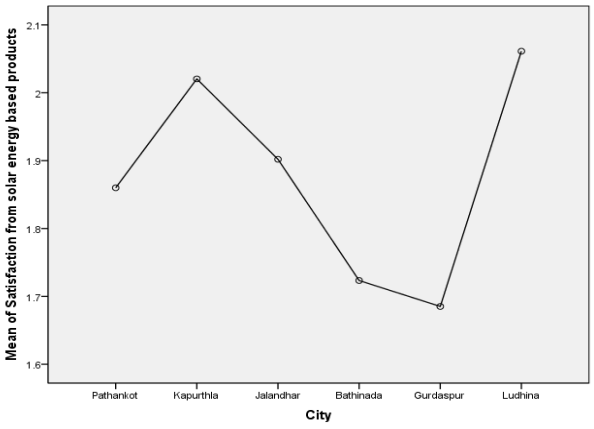

Figure 6: Satisfaction of users from use of solar energy based products across cities.

It can be observed from figure 5.10.1 that satisfaction of users of Ludhiana (2.06) from solar energy products are highest followed by Kapurthala (2.02), Jalandhar (1.90) and Pathankot (1.86). Gurdaspur (1.69) followed by Bathinda (1.72) showed least satisfaction from solar energy products.

Table 4: Post Hoc contrasts (Games-Howell) for Satisfaction from solar energy based products across cities.

Factors	(Age	Mean Difference	Sig.
Pathankot	Kapurthala	-.160	.780
	Jalandhar	-.042	.999
	Bathinda	.137	.880
	Gurdaspur	.175	.690
	Ludhiana	-.201	.572
Kapurthala	Jalandhar	.118	.927
	Bathinda	.297	.165
	Gurdaspur	.335	.063
	Ludhiana	-.041	.999
Jalandhar	Bathinda	.179	.698
	Gurdaspur	.217	.454
	Ludhiana	-.159	.782
Bathinda	Gurdaspur	.038	1.000
	Ludhiana	-.338	.076
Gurdaspur	Ludhiana	-.376	.024

Table 5.10.2 shows individual comparisons of cities with each other calculated through Games-Howell method. Results of test depicts that score of users of Ludhiana were significantly higher from users of Gurdaspur regarding satisfaction from solar energy products, $p < 0.05$.

$H_0$6: *Satisfaction of users from use of solar energy based products do not differ significantly between educational qualifications.*

One-way independent ANOVA was performed to test the hypothesis that satisfaction of users from use of solar energy based products do not differ significantly between educational qualifications. The results of the test have been given in table 5.10.3and figure 5.10.2 respectively.

Table 5: Descriptive statistics and ANOVA results forsatisfaction from solar energy based products on educational qualification

Education	N	Mean	S. D	Lev. Stat.	Sig.	F	Sig.
Matriculate	12	1.75	.754	2.058	.106	.724	.538
Intermediate	53	1.75	.585				
Graduate	184	1.88	.554				
Post Graduate	51	1.86	.601				
Total	300	1.85	.575				

To test homogeneity of variance among group of cities levene test was performed. Levene test is non-significant, $P > .05$, which means that variances among groups are equal, therefore, one-way ANOVA was applied to compare groups. Results shows that satisfaction of users from use of solar energy based products do not differ significantly between educational qualification, so the null hypothesis is accepted, $F(3, 296) = .106$, $P > .05$.

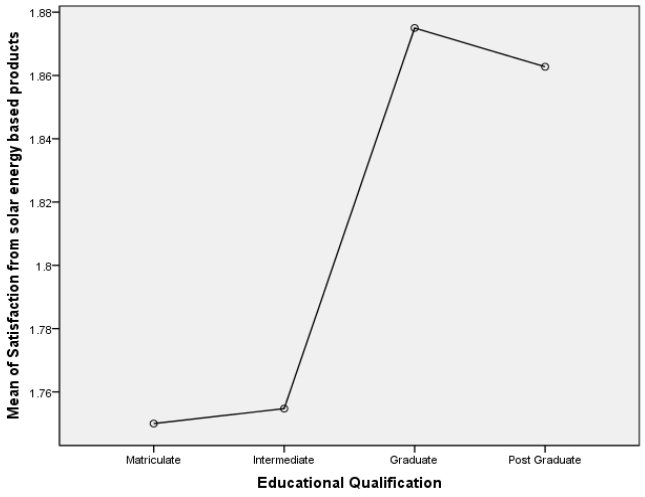

Fig 7: Satisfaction of users from use of solar energy based products on educational qualification

It can be observed from figure 5.10.2 that satisfaction of graduate users (1.88) from solar energy products are highest followed by post-graduate (1.86), intermediate (1.75) and matriculate users (1.75).

$H_0$7: *Satisfaction of users from use of solar energy based products do not differ significantly between occupation.*

One-way independent ANOVA was performed to test the hypothesis that satisfaction of users from use of solar energy based products do not differ significantly between occupation. The results of the test have been given in table 5.10.4 and figure 5.10.3 respectively.

Table 6: Descriptive statistics and ANOVA results for Satisfaction from solar energy based products on occupation.

Occupation	N	Mean	S.D	Lev. Stat.	Sig.	F	Sig.
Govt.	63	1.84	.601	.168	.918	.496	.686
Private	63	1.92	.604				
Own Business	151	1.83	.563				
Retired	23	1.78	.518				
Total	300	1.85	.575				

To test homogeneity of variance among group of occupation, levene test was performed. Levene test is non-significant, P > .05, which means that variances among groups are equal, therefore, one-way ANOVA was applied to compare groups. Results shows that satisfaction of users from use of solar energy based products do not differ significantly between occupations, so the null hypothesis is accepted, F (3, 296) = .686, P > .05.

Fig 8: Satisfaction of users from use of solar energy based products on occupation.

It can be observed from figure 5.10.3 that satisfaction of users belonging to private occupation group (1.92) from solar energy products are highest followed by government employees (1.84), own business (1.83).Retired category users(1.78) showed least satisfaction from solar energy products.

$H_0$8: *Satisfaction of users from use of solar energy based products do not differ significantly between educational qualifications.*

One-way independent ANOVA was performed to test the hypothesis that satisfaction of users from use of solar energy based products do not differ significantly between educational qualifications. The results of the test have been given in table 5.10.5and figure 5.10.4 respectively.

Table 7: Descriptive statistics and ANOVA results forsatisfaction from solar energy based products on educational qualification

Education	N	Mean	S.D	Lev. Stat.	Sig.	F	Sig.
Matriculate	12	1.75	.754	2.058	.106	.724	.538
Intermediate	53	1.75	.585				
Graduate	184	1.88	.554				
Post Graduate	51	1.86	.601				
Total	300	1.85	.575				

To test homogeneity of variance among group of cities levene test was performed. Levene test is non-significant, P > .05, which means that variances among groups are equal, therefore, one-way ANOVA was applied to compare groups. Results shows that satisfaction of users from use of solar energy based products do not differ significantly between educational qualification, so the null hypothesis is accepted, F (3, 296) = .106, P > .05.

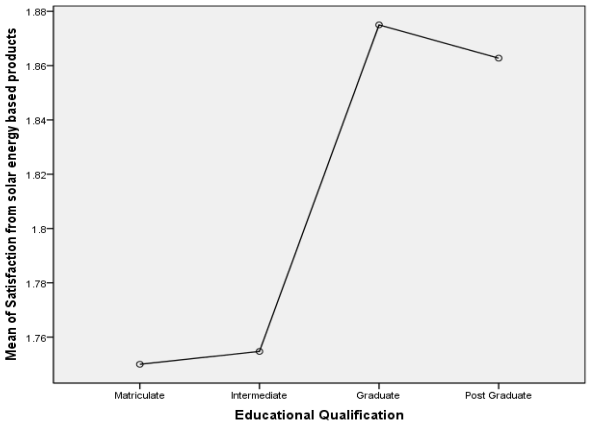

Fig 9: Satisfaction of users from use of solar energy based products on educational qualification

It can be observed from figure 5.10.4 that satisfaction of graduate users (1.88) from solar energy products are highest followed by post-graduate (1.86), intermediate (1.75) and matriculate users (1.75).

$H_0$9: *Satisfaction of users from use of solar energy based products do not differ significantly between income.*

One-way independent ANOVA was performed to test the hypothesis that satisfaction of users from use of solar energy based products do not differ significantly between income. The results of the test have been given in table 5.10.6and figure 5.10.5 respectively.

Table8: Descriptive statistics and ANOVA results for Satisfaction from solar energy based products on income.

Income	N	Mean	S.D	Lev. Stat.	Sig.	F	Sig.
Up to 50,000	130	1.93	.587	1.776	.171	2.664	.071
50,000-1,00,000	111	1.80	.600				
Above 1,00,000	59	1.75	.477				
Total	300	1.85	.575				

To test homogeneity of variance among group of income, levene test was performed. Levene test is non-significant, P > .05, which means that variances among groups are equal, therefore, one-way ANOVA was applied to compare groups. Results shows that satisfaction of users from use of solar energy based products do not differ significantly between occupations, so the null hypothesis is accepted, F (2, 297) = 2.664, P > .071.

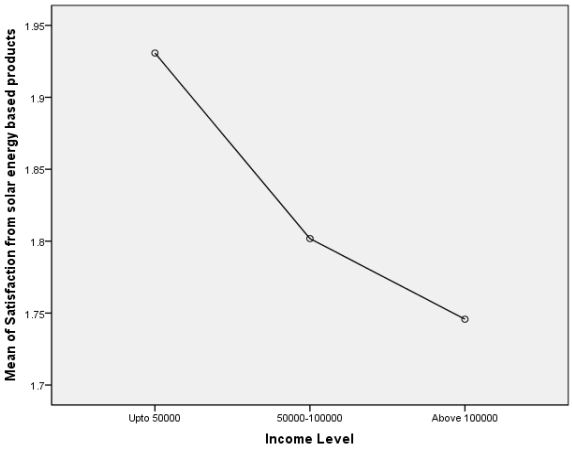

Fig 10: Satisfaction of users from use of solar energy based productson income.

It can be observed from figure 5.10.5 that satisfaction of users earning up to 50,000 income group (1.93) from solar energy products are highest followed by 50,000-1,00,000 group (1.80) and above 1,00,000 income group (1.75).

MOTIVES FOR USING SOLAR ENERGY BASED PRODUCTS

Table9: Motives for using solar energy based products

S. No.	Motives for using solar energy based products	Yes	No	Yes %
1.	Less dependence utility on conventional sources	83	217	27.7
2.	No power cut	199	101	66.3
3.	Solar energy systems are virtually maintenance free	89	211	29.7
4.	For ecological balance Solar energy resources should be promoted	64	236	21.3
5.	Using Solar energy resources would remove the negative effects of the greenhouse gasses	63	237	21.0
6.	Using Solar energy resources will decrease the usage of fossil fuels, which are the biggest cause of global warming	101	199	33.7

Motives for using solar energy based products are shown in table 9. No power cut is the major motivator for using solar energy products followed by decreasing usage of fossil fuels, maintenance free energy, promote ecological balance and remove negative effects of greenhouse gasses.

III. CONCLUSION

This Study conclude that there is significant difference between the city for familiarity of solar energy based product.

There is no significant difference between the educational qualification, occupation & income wise familiarity of users with solar product. The familiarity of users of Gurdaspur were significantly lower than from familiarity of users of Pathankot, Kapurthala and Jalandhar with solar energy products. There is significant difference between the city for satisfaction of solar energy based product. There is no significant difference between the education qualifications , occupation & Income wise satisfaction of users with solar product. Users of Ludhiana were significantly higher from users of Gurdaspur regarding satisfaction from solar energy products . No power cut is the major motivator for using solar energy products followed by decreasing usage of fossil fuels. For generalization of results of present study outside Punjab, study may be replicated at national & worldwide level.

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