International Journal of Applied Engineering Research
ISSN 0973-4562 Volume 10, Number 8 (2015) pp. 19213-19226

http://www.ripublication.com

Consumer Attitudes Towards Domestic Solar Water Heaters

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ABSTRACT

Growth and development of human race is based on the contribution of energy from different sources. Solar energy is an easily available renewable energy source. This study on solar water heater users was carried out in Coimbatore City which has an active local solar water heating industry. This article is an attempt to analyze the consumers' attitude, awareness and satisfaction level with regard to usage of Solar Water Heater (SWH) devices. It emphasizes how a smart marketing strategy is needed to address the barriers in introducing solar energy devices to the public.

Key Words: Energy - Renewable Energy - Solar Energy - Solar Energy Devices -Solar Water Heater - Marketing Strategy

I. INTRODUCTION

Energy is a natural resource and one of the basic pre-requisites of life. Growth and development of human race is based on the contribution of energy from different sources. Without energy, our entire civilization and its technical developments such as transport and communication, food production and commercial activities would cease. The two types of energy resources that are widely used by people are non-renewable or conventional energy and renewable or non-conventional energy. Conventional energy resources are the natural resources that are contained in the earth in fixed quantity like coal, oil, wood, fossil fuel, etc.; whereas non-conventional energies are energies from the sun, wind and ocean, etc., which are available naturally and incessantly. Right from ancient days, conventional energy such as the energy from wood, oil and coal were widely used by people in domestic, industrial and commercial sectors.

Since the demand for conventional energy has been increasing day by day, the nation may face a domestic fuel shortage in near future. Over exploitation of conventional energy leads to environmental degradation which is gradually assuming the dimension of threatening the very existence of mankind. In order to overcome this problem, the use of non-conventional energy which is abundantly available is being promoted in domestic and commercial sectors.

Solar energy is produced through radiation from the sun which is man's greatest natural resource. Solar energy plays a crucial role in large scale energy production in India where electricity consumption has been ever-increasing. It is pollution-free and therefore, leads to subsiding of greenhouse effects.

Our country obtains solar radiation approximately above 5,000 trillion kWh/year, which is much higher compared to India's total energy utilization. Depending on the geographical position, the average solar radiation received by India ranges from 4-7 kWh/m^2. Hence, there are numerous technological devices invented that produce electricity from solar power. Among them, solar water heaters (SWH) or solar flat plate collectors and solar cookers have been widely used in domestic sectors. It is believed that solar water heater is of no use in hilly areas due to the cold climate but scientifically it has been proved that at higher elevations when the atmosphere is free from dust and moisture the intensity of radiation is quite high. Therefore, solar water heaters are operating very successfully in these regions.

As per report released by the Ministry of New and Renewable Energy and Solar Thermal Federation of India, a 2 sq meter solar collector area can replace an electric heater of 2 kW capacity. On an average, it can save around 1200 kW of electricity or around 140 liters of diesel if used for 300 days. The replacement of electric heaters by solar heaters will help saving electricity and minimize peak load demands. In addition, a 100 liter solar water heater helps in reducing 1.5 tons of carbon dioxide emissions per year.

Solar water heater or solar flat plate collector

Domestic solar water heater comprises of an insulated water storage tank with an inlet feeding cold water and an outlet for hot water. The cold water is passed through an iron pipe fitted with a glass plate collector. The water absorbs heat from the collector, gets heated and moves upward into the upper portion of the storage tank from where it can be taken through the outlet for use. These types of solar water heaters are fixed on the top of the house roof so that they absorb solar radiation directly from the sun for domestic use solar hot water supply is given through insulated pipe fittings which are fixed in the kitchen, bathroom, wash basins, etc.

The average cost of a solar water heater is Rs.20,000 to 25,000 (100 liter capacity) depending on its quality. So, the cost could be recovered in three to four years with the lifespan of the equipment extending to almost 10 years. For 100 liters (on average), 3-3.5 electrical units are saved per day of heating. By this yardstick, a solar water heater can help to save approximately Rs.10,000 a year.

II. LITERATURE REVIEW

The review of related literature to this study shows how several studies have been undertaken to emphasize the importance of renewable energy in India. Ashwani Kumar et al. [1] view that energy sources and technologies that are renewable have the capacity to be the key to old energy problems that developing countries face. To overcome the shortage of energy in India, renewable energy sources can be used. India, which is fast growing economy will require thrice the amount of energy that is consumed today to meet the requirements of energy. One of the options to meet the requirements is the renewable energy. As per the latest trends, 33 percent of India's energy consumption is renewable. India is responding positively and adopting renewable energy techniques and gives importance to lower air pollution, carbon emissions for guaranteeing a better future sustainability. For the past two and half decades, India has witnessed a greater interest in activities concerned with the application of energy technologies that are renewable for usage in different sectors.

According to Eric Martinot et al. [2], the use of renewable energy has moved from the periphery to widespread and centre space. The study stresses on the fact that the renewable energy technologies should be effectively used for the environmental and social benefits in developing countries like India, Brazil, Bangladesh, etc. where proportion of rural homes with electricity is only 20-30%. Despite decades of development of energy programs and ventures, rural sections with millions of households have low exposure to renewable technologies that can serve as source of livelihood and other social benefits like domestic and community lighting, agriculture water pumps, small scale industry, cooking and hot water. Experience suggests that to expand renewable technologies to sustainable markets, the indispensible driving forces are promotional subsidies and higher focus on income generation and social benefits.

Solar energy is one of the renewable energies, which is readily and endlessly available, but research studies indicate the various implications in marketing solar energy devices.

Venkatraman & Sheeba [3] in their research have analyzed the evolution of the solar energy devices market by studying the customer's attitude, opinions and difficulties in using solar devices. The study targets the current users and aims at understanding their viewpoint on benefits and challenges, reasons for choosing solar over electrical devices and the level of satisfaction. The study finds that most of the users are highly satisfied and a significant relation of the cost factor on the customer's choice on the basis of their monthly income and electricity bill.

The consumer attitude study by Adam Faiers & Charles Neame [4] adopted Kelly's Repertory grid method using personal interviews where the users were allowed to choose words that describe solar power products that added value rather restricting them to the researcher's own technical jargons. This approach gave some interesting realistic expectations of the people like aesthetic factors like minimal visual intrusion affecting landscape, financial aspects like increasing property value, short payback period and maintenance free. The study also highlights the effective use of personal profile for target marketing and communication.

Aseem Prakash [5] research examines green marketing strategies where he recalls that societal marketing aimed at social and environmental benefits needs fine structuring and execution of programs that will increase the acceptability of a moral system with social motive among the target group as per Kotler [6]. He stresses that social marketing is the process of determining the needs of the target market and serve such that it achieves consumer satisfaction as well as societal well-being. These collective sacrifices with the right messaging will persuade customers to change their attitude.

Yee Ling [7] adopted the original theory of planned behaviour by Icek Azjen [8] linking beliefs and behaviour developed to improve the theory of reasoned action which states that the suggested behaviour (attitude) along with social influence leads to intentions (motivation) and ultimately buying behaviour; Yee Ling from here derived his theoretical framework with plans to purchase as the dependent variable driven by independent variables like environmental concern, perceived cost, maintenance, government subsidies and aesthetics factors.

Moula et al. [9] and Patrick Devine-Wright [10] have recognized social acceptance as the critical theme impacting the extensive implementation of renewable energy technologies. They have found that the general public does not have the same perspective as energy technologists. To them, the reason has been the failure to capture all determinants of public acceptance like multiple personal, psychological and contextual factors for genuine understanding of public engagement.

Hence, in future, it is important to adopt innovative methods to deeply analyze people's knowledge and all variables related to acceptability of renewable energy so that they become consistent with energy thinkers.

It is very essential to take up the marketing job of solar energy seriously to have greater impact and Rosoff and Sinclair [11] have rightly assessed the lower market penetration of solar technology which suggests that people have reluctance and apprehension about solar devices that are obstructing its market growth. A detailed marketing plan process has been recommended starting from doing customer research, identifying barriers and opportunities, setting marketing goals, planning programs and tactics, developing budget and finally execution and monitoring sales. Thus, it is vital to create a rigorous plan with a comprehensive approach to solar marketing to expand the customer base for solar energy which is currently not being undertaken by the government or any other organizations in India.

III. RESEARCH OBJECTIVES

1. To study the awareness and attitude of respondents towards domestic solar water heater
2. To study respondents' satisfaction towards solar water heater
3. To determine the challenges and implications in marketing solar devices to public and to suggest smart solar marketing strategies

IV. METHODOLOGY

This study of solar water heater users was carried out in Coimbatore City which has an active local solar water heating industry. Coimbatore has a moderate climate. For almost 9 months of the year, the average minimum daily temperature is between 18-22^{o}C and hence the demand for hot water is high.

Coimbatore, the second largest city in Tamilnadu is the headquarters of the Coimbatore District and a Municipal Corporation. The city is segregated into five administrative zones – East, West, North, South and Central zones. The north zone which lies in the belt of Nilgris, where the demand for hot water is more due to chill weather, is the area of this research study. The north zone has 20 wards, among them 5 wards have been selected at random. Consumers who have installed solar water heater with the subsidy provided by the Tamilnadu Energy Development Agency from August 2013 to 2014 have been identified as the universe which consists of 574 solar water heater users. By applying purposive sampling method, in total, 112 sample respondents, who are willing to extend their cooperation for this research study have been selected.

V. ANALYSIS AND INTERPRETATION

A detailed analysis of the collected data has been done using SPSS Statistics 20 that has been presented.

Table 1: Characteristics of the sample respondents

S. No.	Age	Frequency	Percent
1	18-30 yrs	25	22.3
2	31-45 yrs	37	33.0
3	46-60 yrs	35	31.3
4	>60 yrs	15	13.4
	Total	112	100.0
S. No.	**Gender**	**Frequency**	**Percent**
1	Male	73	65.2
2	Female	39	34.8
	Total	112	100.0
S. No.	**Education**	**Frequency**	**Percent**
1	High school	7	6.3
2	Higher secondary	25	22.3
3	Under graduate	61	54.5
4	Post graduate	19	17.0
	Total	112	100.0
S. No.	**Occupation**	**Frequency**	**Percent**
1	Government Service	22	19.6
2	Business	46	41.1
3	Private Service	22	19.6
4	Homemaker	10	8.9
5	Retired	3	2.7
6	Others	9	8.0
	Total	112	100.0
S. No.	**Family Size**	**Frequency**	**Percent**
1	1-2	8	7.1
2	3-4	82	73.2
3	5-6	21	18.8
4	>6	1	.9
	Total	112	100.0
S. No.	**Monthly income**	**Frequency**	**Percent**
1	<Rs.20,000	4	3.6
2	Rs.20,000 - Rs.40,000	30	26.8
3	Rs.40,000 - Rs.60,000	43	38.4
4	>Rs.60,000	35	31.3
	Total	112	100.0
S. No.	**Type of house**	**Frequency**	**Percent**
1	Owned	100	89.3
2	Rented	12	10.7
	Total	112	100.0

It could be inferred from the above table that the majority of the respondents i.e. 33 percent fall in the age group of 31-45 years followed by 31 percent of the respondents whose age group fall into 46-60 years. While 22.3 percent of the respondents belong to 18-30 years of age and 13.4 percent belong to the age group of above 60 years. Gender- wise analysis of respondents shows that 65.2 percent are male respondents followed by 34.8 percent of female respondents.

Nearly half of the respondents i.e. nearly 54.5 percent are graduates, 22.3 percent of them have completed higher secondary education. While 17 percent of them are post-graduates, a minimum of 6.3 percent completed high school education only indicating that educated people are more aware and inclined to adopt solar technology.

The occupation-wise classification of respondents shows that 41.1 percent of the respondents are involved in business. The respondents who are working in the government sector and private sector have the same share of 19.6 percent. Homemakers, retired persons and others have their share of 8.9, 2.7 and 8.0 percent respectively. Nearly three-fourth of the respondents belongs to the family size of 3-4. 38.4 percent of the respondents earn a monthly income of Rs.40,000 - Rs.60,000 followed by 31.3 percent of the respondents who earn above Rs.60,000. The majority of the respondents i.e. 89.3 percent using SWH reside in their own houses.

Table 2: Awareness of SWH through various sources of information

S. No.	Source of Information	Frequency	Percent
1	Friends	38	33.9
2	Seen at homes	32	28.6
3	Advertisements	15	13.4
4	Exhibition	14	12.5
5	Awareness camp	9	8.0
6	Internet	4	3.6
	Total	112	100.0

The above table clearly indicates the awareness of respondents through various sources of information. 34 percent of the respondents were informed about SWH through friends, while 28 percent got aware of the products through visibility at other homes. Advertisements, exhibition, and awareness camp are other sources of information mentioned by 13.4, 12.5 and 8 percent of the respondents. Only 3.6 percent of the respondents mentioned that they got aware of these products through the internet. This revels that there are not enough advertisements and campaigns used to promote solar devices.

Table 3: Reliability coefficients for attributes

Attributes	Cronbach Reliability Coefficient
Encouraging factors	0.793
Challenges	0.785
Preference and Satisfaction	0.734
Marketing Strategies	0.880

Since all the attributes have the Cronbach reliability coefficient of above 0.7, there is high internal consistency among the attribute items.

Table 4: Encouraging factors of SWH among users

Attributes	Mean	Std. Deviation
Saves electricity	3.37	1.00
Promotional subsidies	3.80	0.80
Cost-Effective	2.80	0.80
Pollution-free and environment friendly	2.63	0.89
Easily available in market for purchase	2.79	0.86
Easy installation and maintenance	2.79	0.86

Among the encouraging factors to buy SWH, promotional subsidies have the highest mean score of 3.80 followed by saving electricity with the mean score of 3.37. Cost-effectiveness ranks the third most driving factor with a mean of 2.8 due to onetime installation cost and payback nature. The statement - Saves Electricity has found significant variations in the responses with comparatively high standard deviation (1.00). Thus, there are higher differences among users' responses. As compared to this, more cohesiveness is seen in statements - Cost effectiveness and Pollution-free and environment friendliness of SWH.

Table 5: Challenges faced by users in using SWH

Attributes	Mean	Std. Deviation
Inadequate technical knowledge and complexity in usage	2.67	0.78
Low efficiency during winter and rainy days	3.94	0.79
High installation cost and longer payback period	3.38	1.02
Problems of leakage and scaling due to poor water quality	2.71	0.82
High cost of maintenance	2.79	0.84
Poor Service	2.20	0.76

Among the challenges in using SWH, low efficiency during winter and rainy days has been identified as the main problem by users with the highest mean score of

3.94, followed by high installation cost and longer payback period with the mean score of 3.38. The high cost of maintenance, problems of leakage and scaling due to poor water quality, inadequate technical knowledge and complexity in usage are the other challenges for the users which have the mean score of 3.34, 2.79 and 2.67 respectively. Poor service has the least mean score of 2.20. The statement - High installation cost and longer payback period has found significant variations in the responses with comparatively high standard deviation (1.02). Thus, there are higher differences of opinion.

Table 6: Preference, Recommendation & Customer Satisfaction among SWH users

Attributes	Mean	Std. Deviation
Will you prefer to buy solar devices in future?	3.45	0.99
Will you recommend others to buy solar energy devices?	3.91	0.83
I am satisfied with the use of SWH	3.42	1.03

All users have most agreed they would recommend SWH to others which has the highest mean score of 3.91. Preference to buy solar devices in future has a moderately high score of 3.45 and the level of satisfaction with the use of SWH has a mean score of 3.42 signifying that they are moderately satisfied. The statement - Satisfaction with the use of SWH has found significant variations in the responses with comparatively high standard deviation (1.03). Thus, differences are slightly higher in the satisfaction level among users.

Table 7: Marketing Strategies ranked on Effectiveness as per SWH users

Marketing Strategies	Mean	Std. Deviation
Educate the masses about eco friendly and cost effective solar technology	3.40	0.95
Installing solar in high visible locations	3.57	1.00
Building strong supplier network and making purchase easy	3.96	0.94
Providing subsidies and loans	3.89	0.95
Use traditional and modern media to build awareness about value of solar	3.57	1.03
Use of solar water heaters should be made mandatory to reduce electricity consumption	3.38	1.05
Use of solar water heaters should be made feasible for apartment houses	3.92	0.75

Among marketing strategies, building strong supplier network and making purchase easy has been rated the most effective one with the highest mean score of 3.96, followed by use of solar water heaters should be made feasible for apartment houses and providing subsidies and loans, with mean scores of 3.92 and 3.89 respectively. Installing solar in high visible locations and use traditional and modern media to build awareness about the value of solar, share the same mean scores of

3.57. Educate the masses about eco friendliness and cost effectiveness of solar technology and use of solar water heaters should be made mandatory to reduce electricity consumption have the least mean scores of 3.40 and 3.38 respectively.

Table 8: Correlation between Customer Satisfaction and Encouraging factors

Pearson Correlation Coefficient	Saves electricity	Promotional subsidies	Cost-Effective	Environment friendly	Easily available in market	Easy installation & maintenance	Preference to buy in future	Recommendation to others	Customer Satisfaction
Saves electricity	1	.570**	.447**	.356**	.361**	.338**	.385**	.577**	.434**
Promotional subsidies	.570**	1	.484**	.261**	.445**	.384**	.404**	.512**	.461**
Cost-Effective	.447**	.484**	1	.412**	.393**	.345**	.438**	.444**	.417**
Environment friendly	.356**	.261**	.412**	1	.246**	.427**	.404**	.367**	.380**
Easily available in market	.361**	.445**	.393**	.246**	1	.425**	.438**	.411**	.376**
Easy installation & maintenance	.338**	.384**	.345**	.427**	.425**	1	.277**	.451**	.353**
Preference to buy in future	.385**	.404**	.438**	.404**	.438**	.277**	1	.375**	.503**
Recommendation to others	.577**	.512**	.444**	.367**	.411**	.451**	.375**	1	.570**
Customer Satisfaction	.434**	.461**	.417**	.380**	.376**	.353**	.503**	.570**	1

*Note: The symbol ** indicates that the coefficient values are significant at 0.05 significance level*

Customer Satisfaction with the use of SWH shows good positive correlation with encouraging factors to buy SWH. Among the encouraging factors, promotional subsidies have the highest correlation with satisfaction with the use of SWH i.e. 0.461 followed by saving electricity, cost-effectiveness, pollution-free and environment friendly, easy availability in the market for purchase with the correlation co-efficient of 0.434, 0.417, 0.380 and 0.376 respectively. Easy installation and maintenance has the lowest correlation of 0.353 with customer satisfaction in using SWH. It is evident that when as provision of promotional subsidies and cost-effectiveness increases, there will be higher satisfaction among consumers using SWH.

VI. DISCUSSION AND RECOMMENDATIONS

Solar water heater is one of the advanced technical innovations, which fulfill the needs of households to a large extent. The use of such innovations helps saving time,

electricity and provides hot water free of cost. By using renewable energy resources, limited conventional energy resources could be stopped from human destruction to the threshold. Moreover, burning kerosene, wood and charcoal emits smoke that pollutes the environment. Thus, the efficient use of solar energy would relieve the pressure on rapidly depleting non-renewable energy sources and help to save our environment through lesser pollution and safeguarding natural resources.

Apart from solar water heaters, solar energy can be used for multiple purposes in domestic sector such as solar cooker, solar light, solar ACs, etc. The key challenge for the solar energy industry is the lack of awareness about the solar systems and their non-availability in the market that will make the purchase easy for consumers. Despite this, there are a major portion of solar conscious consumers who are not coming forward for solar installations due to reasons like high initial cost and the complicated process involved in installations and maintenance.

The main reasons that have brought solar systems into existence are its environment friendliness and renewable nature and are the crucial factors for energizing demand. However, based on the analysis and interpretation, it can be substantiated that environment and pollution concern has been given the least importance while provision of subsidies is the major factor driving sales of solar systems. This public attitude of least concern for the environment has been a major problem area in India that needs to be dealt with which has been highlighted by the lower rating given by the respondents in our research. For higher sales and installations of solar devices, it is essential to understand the customers' state of mind and needs, then identify the major challenges in real-time use of these devices and frame a detailed marketing strategy. As per research findings, the major challenges to the solar market growth can be summarized as:

Cost

There has been a disparity in the solar pricing perspective between the consumer's expectations and the ground reality with high investments needed which is limiting market growth. Also, the recent decision of the Indian Government to stop the subsidy from Oct 2014 is forcing many solar water heater suppliers to shut down operations. This will further discourage people from shifting to solar devices.

Reliability

Solar energy systems are still rare and not visible in our daily life; this invisibility contributes to the concern about its reliability. Also, it is not possible to be completely dependent on solar devices due to its lower efficiency during rainy days.

Complexity

Consumers often overwhelmed by the complexity of installing solar and most of them are more conservative about the new technology.

Inertia

Consumers are usually reluctant and indolent to shift to solar products that require a lot of time, research and understanding.

It is vital to plan a systematic approach and frame an effective marketing plan to address these barriers, improve and monitor the market growth of solar devices. Deriving inputs from respondents who are real-time consumers, some of the favorable marketing strategies that will draw public attention and purchase of solar devices have been discussed.

The first and foremost policy should be to create awareness about solar products. The government, private agencies and NGOs should take up major responsibility in educating public about the value of solar energy and its benefits. Since subsidies have been the main encouraging factor among solar adopters, the Indian government should actively be involved in advertising, providing subsidies and loans to promote solar devices.

It is important to use both traditional and modern mediums of advertising to reach extensive urban and rural masses. The right, customer friendly messages should be identified and ensure that be clear, consistent and aligned to the value marketing strategy.

Certain other advertising strategies advisable are identification of target groups and conducting free solar workshops with the help of NGO's and private stakeholders, installing solar in highly visible locations, etc.

After spreading awareness and goodwill, the second step should focus on building a strong supplier network for better public reach and easy purchase. It is essential to have a high number of suppliers in the open market to improve visibility and make the buying task easy. Also, a major responsibility rests on the suppliers to create buzz and demand for solar devices to accelerate market growth and develop a profitable business which is ultimately in their benefit. Private agencies can also use promotional incentives to outlets and sales representatives to encourage sales of solar energy devices.

Most of the current housing structures in India are not compatible to install solar devices such as photovoltaic cells, heaters, etc. which require large space and an open terrace with maximum sun exposure. Currently, almost all solar devices installed are in independent houses and not in apartments due to feasibility and ownership constraints. Hence, the private builders constructing apartments and high rise residential buildings should take care that their constructions are suitable for solar device installations. Another promotional strategy by the government can be provision of certain benefits to builders adopting solar technology.

Finally, the respondents also agreed that bringing in strict regulations such as mandatory use of solar water heaters to reduce electricity consumption, higher subsidies and loans, strict implementation of solar at least in government institutions, etc. can be helpful in making people comfortable about, realize their importance and covert them into adopters and daily users.

With the fast depleting natural resources of the country and ever-increasing electricity consumption is an alarm implying the need for large scale conversion to renewable energy sources and especially solar. People’s apprehension and inertia are the major barriers preventing them to adopt this new technology themselves. Hence to motivate people, primarily the government and private agencies should take

accountability and adopt effective marketing strategies suggested to bring about the solar revolution.

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