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Development of Solar Water Heater using Product Development Approach

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Abstract
The global demand for energy is growing and conventional energy source are depleting and non-conventional energy sources as an alternative to the conventional methods. In a country like India its potential has not yet been adequately realized. The renewable energy are the clean sources of energy and using those resources reduce environmental impacts, produce less secondary wastes and are sustainable based on current and future economic and societal need. This project presents a consolidate review of solar water heater related issues covering these customers' needs, marketing research. The Questionnaires were used as a research tool to understand the opinions of the customers. The research design is descriptive research. The data was mainly to use and collect the primary data. The analysis helped the project by giving suggestions for customer's expectations and developed a domestic parabolic through solar water heater model. Prototype "optimization" in final stages of the product development process has been identified as a product success for product development process. This step is often unnoticed. This may be due to lack of occasion.

I. INTRODUCTION

Energy sources are playing an important role. The increase in population growth, industrialization and standard of living in recent years has led to a rapid increase in energy demand [1]. The growing energy demand could be met by conventional fossil fuel energy sources like coal, oil, etc., and non-conventional energy sources like wind, solar, geothermal, etc. However, the increased use of fossil fuels lead to the fast exhaustion of the resources and contributes to global warming [2]. This energy demand is compete by the Renewable or non conventional energy sources.

The solar energy is an important one in the renewable energies. Their great quantity and less cost are two great tactical advantages. This solar energy used as an alternative for developed and developing countries [3].Many of the country produces solar water heater. China is the biggest solar water heater manufacturer and investment country in the world [4].In this project to be analyse the market and customer need, developed the product prototype.

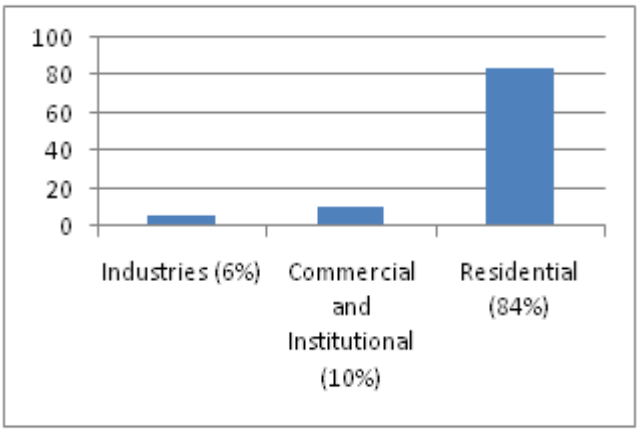

Figure 1 Percentage- share of sectors in SWH installation 2022 [12]

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II. METHODOLOGY

2.1. Phase I: Secondary data collection & planning of survey

This secondary data collected on domestic solar hot water system sector. This information consisted of domestic products, barriers and markets.

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TEST Engineering & Management

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ISSN: 0193 - 4120 Page No. 14936 - 14943

2.2. Phase II: Study (primary data collection)

The key purpose of the survey was to gather information on DHWS:

- Hot water requirement (increase trends).
- Conventional and non conventional energy/fuel/technology used.
- Consumer interest
- Local polices and their enforcement.
- Product price/payback period/services /requirement time/
- Renewable energy trend/awareness

2.3. Phase III: Opportunity identification

- Understand customers need

2.4. Phase IV: Development and Optimization

III. LITERATURE SURVEY ON DSWH POTENTIAL

Solar water heater of small size, suitable to assure domestic hot water need, offers environmental friendly way in order to achieve better future [5]. It is estimated that a domestic solar water heater system of 100L per day capacity can reduce about 1237 kg of CO_2 emissions in a year at 50% capacity utilization and in hot and sunny region can reduce 1410.5 kg of CO_2 [6,7]. The general DSHWS collector mounted on horizontal surface, normally in a roof, at a 10^o greater than the local latitude so that it receives optimum incident radiation during the winter months when the hours of sunlight are least. The performance of the heater depends on the selection of materials, thermal conduction of the absorber tube and fins, the ability of the bonding between tube and fins, the quality of the insulation, and the corrosion resistance of the entire system[8].

Garg. Designed and tested the performance of A large SHWS capability of heating 600L of water up to 55^oc in winter months at Roorkee [9]. Year round performance and potential of a natural circulation type SHWS was investigated by Nahar. Based on the performance testing, it had been found that the SHWS can provide 100 liters of hot water at an average temperature of 60.6^oc when the tap water temperature is 23.6^oc, it can retain hot water till next day morning at an average temperature of 51.6^oc, and the overall efficiency is 57%.[10, 11]. In this secondary data is considered for the survey questioner and its planning.

IV. PRIMARY DATA COLLECTION

This primary data collected from the customer through the market survey questioner. This questioner based on the requirement and market of the customers. Following questions are uncounted the customers:

- Do you or any other member of your family require hot water for your bath?
- If your answer to the previous question is yes, please indicate the frequency of your use of hot water for bathing
  a) **Daily, throughout the year.**
  b) **Only during winter months**
  c) Occasionally, but through the year
- What is the current type of heating system you are using for heating water at your home for bathing purposes?
  a) **Electric water heaters (geysers)**
  b) **LPG Stoves**
  c) **Kerosene stoves**
  d) **Wood fired/charcoal based boilers**
- What is your current **monthly** expense on this system **for bath water heating alone**
  a) **Less than Rs.200**
  b) **200 to 500**
  c) **Above Rs.500**
- Do you think that using solar energy could help reduce the threats to our environment and climate?
  a) **Yes, positively**
  b) **May be**
  c) **Definitely not**
- Would you be interested in investing on a solar domestic water heater?
  a) **Yes**
  b) **No**
  c) **May be**
- How much would you be willing to pay for a solar water heater on your own without government subsidy or bank loan?
  a) **Less than Rs.10000**
  b) **10000-15000**
  c) **15001-20000**
  d) **More than Rs. 20000**
- Are you worried that this cost has been increasing year after year and this might not be economical in the years to come?

TEST Engineering & Management

January - February 2020
ISSN: 0193 - 4120 Page No. 14936 - 14943

a) **Yes**

b) **No**

- Do you feel that the Government should provide some kind of a subsidy or income tax exemption on investment to encourage people to buy SWH?
  a) **Yes**
  b) **No. I consider that it is our duty to go for renewable energy sources.**
  c) **No. I think it is affordable as it is, considering the life time use.**
- Would you recommend that some kind of soft-loan from any bank for the purchase of the system would be useful?
  a) **Yes**
  b) **No. It does not remove the problem on personal investment**
- What is the pay-back period you look for in a SWH?
  a) **Less than 5 years**
  b) **5-10 years**
  c) **More than 10 years**
- What is the capacity of the SWH in you expect to use, based on the number of members in your family and your need of hot water for bath?
  a) **Less than 100 liters per day (lpd)**
  b) **100-200 lpd**
  c) **200-300lpd**
  d) **More than 300 lpd**
- How hot do you want the water to be?
  a) **Lukewarm (20-30^{o} C)**
  b) **Warm (30-40^{o}C)**
  c) **Hot (40-60^{o}C)**
  d) **Too Hot (above 60^{0}C)**
- How long were you willing to wait for the water to get heated if you were using other means of water heating?
  a) **5-15 minutes**
  b) **15-30 minute**
  c) **More than 30 minutes**
- Will you recommend switching over to SWHs to your friends and acquaintances?
  a) **Yes**
  b) **No**
- Are you worried that this cost has been increasing year after year and this might not be economical in the years to come?
  a) **Yes**
  b) **No**
- Would you recommend that some kind of soft-loan from any bank for the purchase of the system would be useful?
  a) **Yes**
  b) **No. It does not remove the problem on personal investment**
- Do you feel that the Government should provide some kind of a subsidy or income tax exemption on investment to encourage people to buy SWH?
  a) **Yes**
  b) **No. I consider that it is our duty to go for renewable energy sources.**
  c) **No. I think it is affordable as it is, considering the life time use.**

Around 32 questions and above 250 samples are collected from the customers.

1. Understanding and Suggestions of customer need

These samples are analyzed. From that we can understand the customer want.

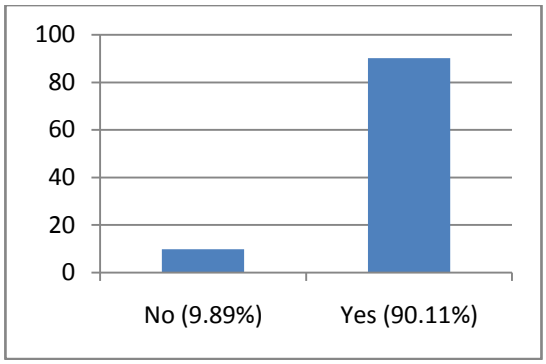

Figure 2 Hot water requirement require for bath

Inference:

From the above figure.2 it is clear that 90.11% of the respondents are require hot water for bath and remaining 9.89% are not require hot water heater. Therefore the hot water must be requiring to the market.

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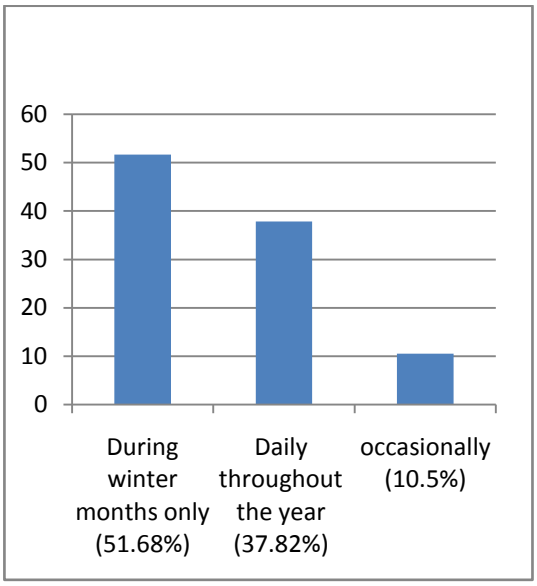

Figure 3 Frequency of use

Inference:

From the above (figure 3) it is clear that 51.68% of the respondents are use HW during winter months only for bathing, 37.82% of the responder are use HW daily throughout the year , and remaining 10.50% are occasionally using the HW. Therefore majority of the respondents are coming into winter mother and also the daily users are required HW.

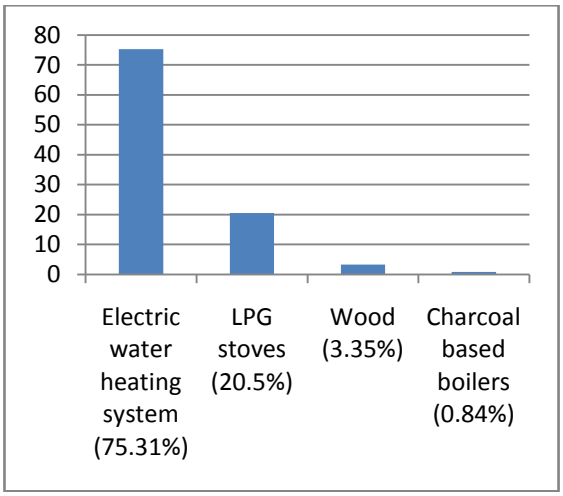

Figure 4 The current type of heating system

Inference:

From the above (figure 4) it is clear that 75.31% of the respondents are using electric water heating system, 20.50% of the respondents are using LPG stoves, and 3.35%, 0.84% of the respondents are using wood/charcoal based boilers fired and kerosene stoves. Therefore majority of the respondents are using electric water heating systems.

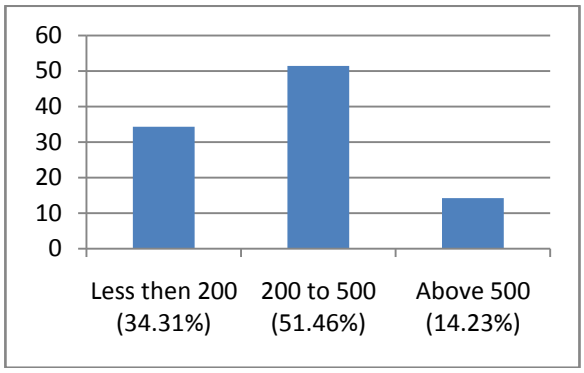

Figure 5 Current monthly expenses for bath alone

Inference:

From the above (figure 5) it is clear that 51.46% of the respondents' current monthly expense for bath alone 200 to 500, 34.31% of the respondents' current monthly expense for bath alone less than 200, 14.23% of the respondents' current monthly expense for bath alone above Rs.500. Therefore majority of the respondents are monthly expense is RS.200 to 500.

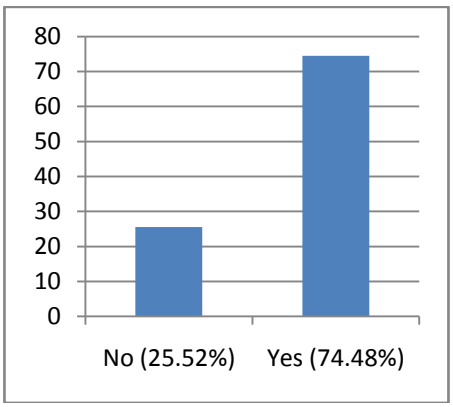

Figure: 6 worried that this cost has been increasing year after year and this might not be economical in the years to come

Inference:

From the above (figure 6) it is clear that 74.48% of the respondents are worried that the cost has been increasing year after year, and 25.52% of the respondents are not worrying that the cost has been increasing year after year. Therefore majority of the respondents are worried that the cost has been increasing year after year.

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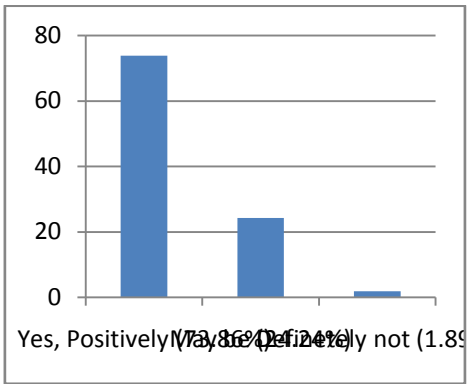

Figure 7 Solar energy could help reduce the threats to our environment and climate

Inference:

From the above (figure 7) it is clear that 73.86% of the respondents are think that using solar energy could help reduce the threats to our environment and climate, 24.24% of the respondents are think that using solar energy may be help reduce the threats to our environment and climate, and 1.89% of the respondents are think that using solar energy could not be reduce the threats to our environment and climate. Therefore majority of the respondents think that using solar energy could help reduce the threats to our environment and climate.

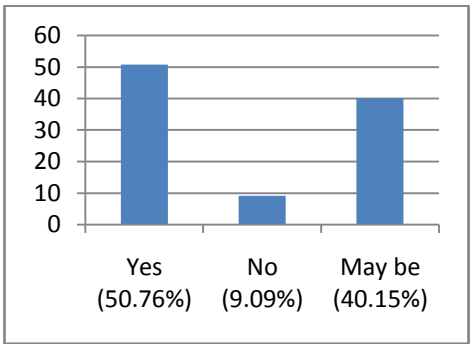

Figure 8 Interest in investing on DSWH

Inference:

From the above (figure8) it is clear that 50.76% of the respondents are interested in investing on SDWH, 40.15% of the respondents are moderately interested in investing on SDWH and 9.09% of the respondents only not interested in investing on SDWH. Therefore majority of the respondents interested in investing on SDWH

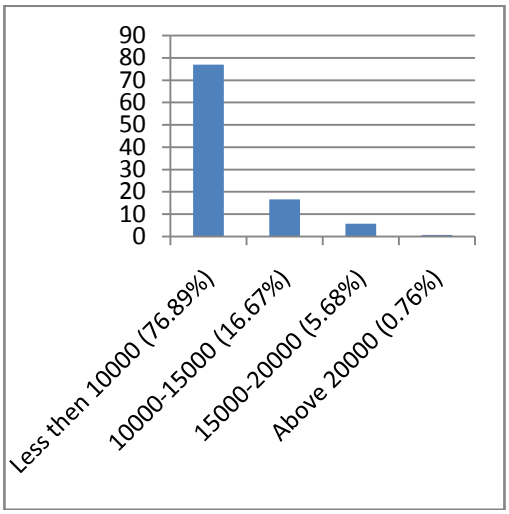

Figure 9 Pay for a SWH on they own

Inference:

From the above (figure9) it is clear that 76.89% of the respondents are willing to pay for a SWH less then Rs.10000, 16.67% of the respondents are willing to pay for a SWH Rs.10000-15000, 5.68% of the respondents are willing to pay for a SWH Rs.15001-20000, and 0.76% of the respondents are willing to pay for a SWH above Rs.20000.Therefore majority of the respondents are expected price is less then Rs.10000.

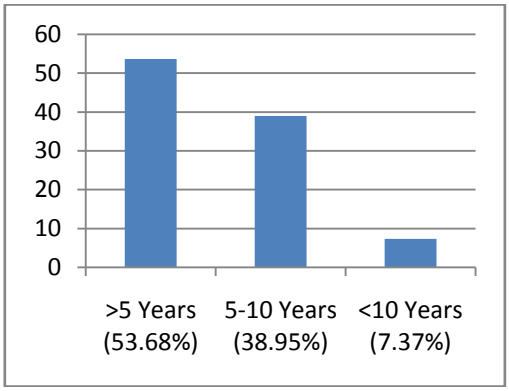

Figure: 10 The SWH payback period

Inference:

From the above (figure 10) it is clear that 51 or 53.68% of the respondents are looking for the SWH payback period is less than 5 years, 37 or 38.95% of the respondents are looking for the SWH payback period is 5-10 years, and 7 or 7.37% of the respondents are looking for the SWH payback period is greater than 10 years, Therefore majority of the respondents are looking for the SWH payback period is less than 5 years.

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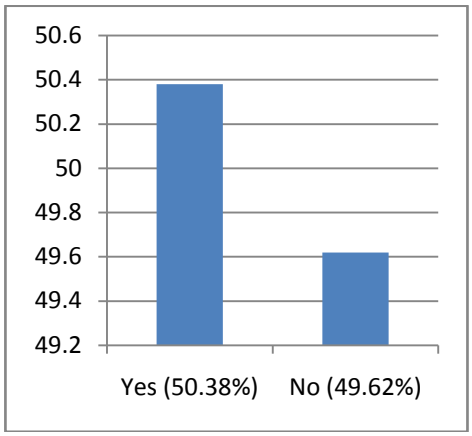

Figure 11 Soft-loans from any bank

Inference:

From the above (figure 11) it is clear that 50.38% of the respondents are recommend that some kind of soft-loan for the purchase of the SWH system would be useful, 49.62% of the respondents are willing to pay for a SWH they own without loan. Therefore it majority of the respondents are recommend that some kind of soft-loan for the purchase of the SWH system.

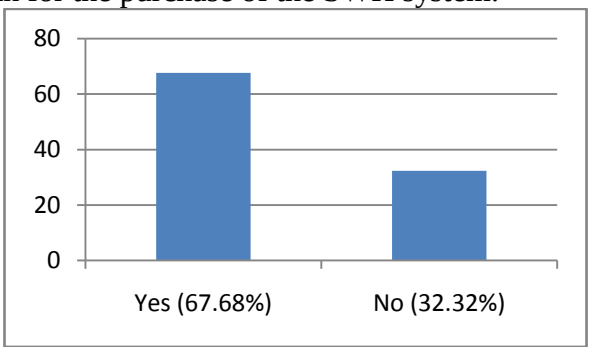

Figure 12 subsidy Government

Inference:

From the above (figure 12) it is clear that 67.68% of the respondents' are recommendgovernment subsidies, 32.32% of the respondents' are don't want the government subsidies. Therefore majority of the respondents are wants the government subsidies.

VI. DEVELOPMENT AND OPTIMIZATION

The SWH developed based on the customers opinions about the factor influencing SWH market. The factors of SWH are generally demand of hot water, type of house, awareness about SWH, household income and policy. the hot water demand for bathing shows significant variation across regions, climatic and also depends on customers behavior[12]. The survey found majority of people wants hot water in morning time. They daily using customers are higher, customers wants HW within 15 minutes, and important low initial cost. The flat plate collector solar water heater costs is around 15000-20000INR and the installation cost also higher[14]

The parabolic trough collector is a serious of curved mirrors are placed which are used to concentrate sunlight on to thermal efficient receiver tubes placed in the through focal line through which synthetic oil, heated to approximately 400^{o}C by the concentrated sunlight (see fig.13) [15].

Fig.13. Parabolic trough [15]

This parabolic through thermal system is to produce more energy and the water can heat wary quick. From the customer can wait 15 minutes so that the parabolic through collector used in this project.

The installation cost also can reduced while type of collector using.

System level Design and detailed design are developed and prepared for testing. (See fig.14)

The design of the parabolic trough solar collector is done by the use of software called as PARABOLA CACULATOR 2.0 which is easily available on the internet. The initial specification for the design of Parabolic Trough Solar Collector is obtained by considering parabolic equation: $X^2=4aY$.

Where,

Y = Distance along vertical axis

a = Focal length

X = Distance along horizontal axis.

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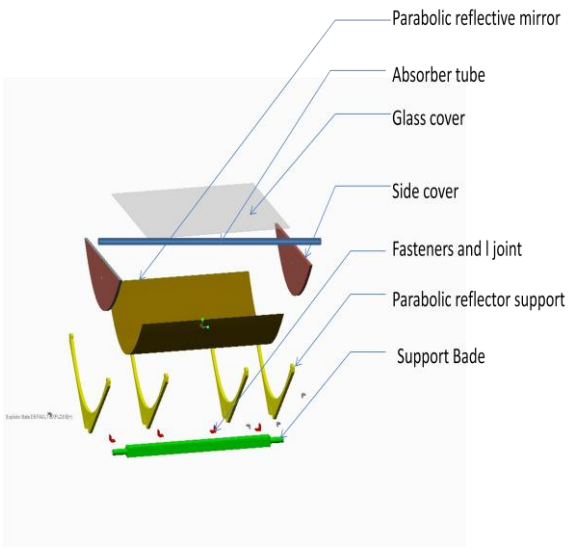

Fig.14 Expanded view of Parabolic through collector

Actual product

Parameter	value
Collector area	0.8 m^2
Storage tank capacity	20 liters
Circulation	Thermo siphoning
Length of collector	1 m
Width of collector	0.8 m
Insulation	Ceramic wool
Collector material	Copper
Collector tube material	Copper
Collector tube size	17 mm
Circulation channels	CPVC pipe

VII. CONCLUSIONS

From the marketing research process the customer wants are identified and listed below:

- Hot water requirement is widely increased.

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- From this sample the customers are mainly considered the renewable energy.
- Most of the customers wants the solar water heater around Rs.10000

- A family of four members requirement of hot water per day is in the region of 100 liters
- Majority of the respondents are wants the government subsidies.

This are all the primary needs to collected from the customers

- Customers are not unique they are different in likes, dislikes and most of them wants a low cost product with good quality. This parabolic through solar water heater approximately less then Rs.15000 and the installation cost also considerably reduce. This will be the sweet able one for the fast changing world.

- This project Prototype "optimization" in final stages of the product development process has been identified as a product success for product development process. This step is often unnoticed. This may be due to lack of occasion.

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