

On field investigation, Reduction in energy consumption by using solar hot water system

¹Ar.Monica Sharma, ²Ar.Shaikh Sohail, ³Ar.Piyush Pant, ⁴Ar.Sonika Sharma

¹Assistant Professor, ²Practicing Architect, ³Assistant Professor, ⁴Practicing Architect
Acharya's NRV School of Architecture,
Bangalore, India

Abstract: This research is based on the finding in the reduction in electricity bill or energy consumption by using "SOLAR HOT WATER SYSTEM" in the low rise and low density buildings. The study of research is focus on three main aspects "Physical, Technical, and Motivational" with related to solar hot water system. It is a Comparative analysis of the residential building in particular area by keeping some variable constant like "Plot size, family structure, and electrical appliance's" between the houses which have installed Solar panels or without solar panels.

Index Terms: Solar Passive Heating; Energy Consumption; Economical

I. INTRODUCTION

The solar energy is the most capable of the alternative energy sources. Due to increasing Demand for energy and rising cost of fossil type fuels (coal, gas or oil) solar energy is considered an attractive source of renewable energy that can be used for water heating in both homes and industry. Heating water consumes nearly 20% of total energy consumption for an average family. Solar water heating systems are the cheapest and most easily affordable clean energy available to homeowners that may provide most of hot water required by a family. Solar heater is a device which is used for heating the water, for producing the steam for domestic and industrial purposes by utilizing the solar energy. Solar energy is the energy which is coming from sun in the form of solar radiations in infinite amount, when these solar radiations falls on absorbing surface, then they get converted into the heat, this heat is used for heating the water. This type of thermal collector suffers from heat losses due to radiation and convection. Such losses increase rapidly as the temperature of the working fluid increases.

II. LITERATURE REVIEW

SWH systems are generally very simple using only sunlight to heat water. A working fluid is brought into contact with a dark surface exposed to sunlight which causes the temperature of the fluid to rise. This fluid may be the water being heated directly, also called a direct system, or it may be a heat transfer fluid such as a glycol/water mixture that is passed through some form of heat exchanger called an indirect system. These systems can be classified into three main categories. (Dilip Johari, 2012)

(A). Active Systems

Active systems use electric pumps, valves, and controllers to circulate water or other heat-transfer fluids through the collectors. So, the Active systems are also called forced circulation systems and can be direct or indirect. The active system is further divided into two categories:

I. Open-loop (Direct) Active System

II. Closed-loop (Indirect) Active System

(I) Open-loop active systems

Open-loop active systems use pumps to circulate water through the collectors. This design is efficient and lowers operating costs but is not appropriate if the water is hard or acidic because scale and corrosion quickly disable the system. These open-loop systems are popular in non-freezing climates.

(II) Closed-loop active systems

These systems pump heat-transfer fluids (usually a glycol-water antifreeze mixture) through collectors. Heat exchangers transfer the heat from the fluid to the household water stored in the tanks. Closed-loop glycol systems are popular in areas subject to extended freezing temperatures because they offer good freeze protection. (Kalogirou, 2004)

(B). Passive Systems

Passive systems simply circulate water or a heat transfer fluid by natural convection between a collector and an elevated storage tank (above the collector). The principle is simple, as the fluid heats up its density decreases. The fluid becomes lighter and rises to the top of the collector where it is drawn to the storage tank. The fluid which has cooled down at the foot of the storage tank then flows back to the collector. Passive systems can be less expensive than active systems, but they can also be less efficient. Thermosiphon system is the best example of passive systems. (Kalogirou, 2004)

(I) Thermosiphon systems

In the thermosiphon system, water comes from the overhead tank to bottom of solar collector by natural circulation and water circulates from the collector to storage tank as long as the absorber keeps absorbing heat from the sun and water gets heated in the collector. The cold water at the bottom of storage tank run into the collector and replaces the hot water, which is then forced inside

the insulated hot water storage tank. The process of the circulation stops when, there is no solar radiation on the collector. Thermosiphon system is simple and requires less maintenance due to absence of controls and instrumentation. Efficiency of a collector depends on the difference between collector temperature and ambient temperature and inversely proportional to the intensity of solar radiation. (Kalogirou, 2004)

(c) Batch systems

Batch System (also known as integral collector storage systems) are simple passive systems consisting of one or more storage tanks placed in an insulated box that has a glazed side facing the sun. Batch systems have combined collection and storage functions. Depending on the system, there is no requirement for pumps or moving parts, so they are inexpensive and have few components in other words, less maintenance and fewer failures. (Kalogirou, 2004)

III. BENEFITS OF SOLAR WATER HEATERS

There are many benefits to owning a solar water heater, and number one is economics. Solar water heater economics compare quite favorably with those of electric water heaters, while the economics aren't quite so attractive when compared with those of gas water heaters. Heating water with the sun also means long-term benefits, such as being cushioned from future fuel shortages and price increases, and environmental benefits.

1. Long-Term Benefits

Solar water heaters offer long-term benefits that go beyond simple economics. In addition to having free hot water after the system has paid for itself in reduced utility bills, you and your family will be cushioned from future fuel shortages and price increases. You will also be doing your part to reduce this country's dependence on foreign oil. The National Remodelers Association reports that adding a solar water heater to an existing home raises the resale value of the home by the entire cost of the system. You may be able to recoup your entire investment when you sell your home.

2. Environmental Benefits

Solar water heaters do not pollute. By investing in one, you will be avoiding carbon dioxide, nitrogen oxides, sulfur dioxide, and the other air pollution and wastes created when your utility generates power or you burn fuel to heat your household water. When a solar water heater replaces an electric water heater, the electricity displaced over 20 years represents more than 50 tons of avoided carbon dioxide emissions alone. Carbon dioxide traps heat in the upper atmosphere, thus contributing to the "greenhouse effect."

3. Be a Smart Consumer

Take the same care in choosing a solar water heater that you would in the purchase of any major appliance. Your best protection is to consider only certified and labeled systems. One such label is put on by the Solar Rating & Certification Corporation (SRCC), a nonprofit, independent third-party organization formed by the solar industry, state energy officials, and consumer advocates to certify and rate solar water heaters. A national standard (OG-300) addresses a variety of concerns, including safety and health, durability and reliability, installation, performance, and operation and maintenance. To meet this standard, a system is rigorously tested. A certified solar water heater carries the SRCC OG-300 label, and the system performance is listed in a published directory. A similar program has been established for Florida by FSEC. Both SRCC and FSEC provide collector testing and rating programs. Find out if the manufacturer offers a warranty, and, if so, what the warranty covers and for how long. If the dealer you are buying the equipment from goes out of business, can you get support and parts from the manufacturer, or from a local plumbing contractor? Make sure that the workers who are actually installing the system are qualified to do the work. Ask the installation contractor for references and check them. When the job is finished, have the contractor walk you through the system so you are familiar with the installation. And be sure that an owner's manual with maintenance instructions is included as part of the package. (R. Herrero Martín, 2011)

IV. METHODOLOGY

This research paper is based on the study of solar panel and its usage in residential bungalows and reduction in electricity bill by using solar hot water system. study has done in pune moderate climate in Katraj area. For this two societies samples with considering some parameter constant like residential building, plot size etc.

A comprehensive literature review was conducted to obtain the information needed for pursuing the objective of research. Information is obtained from interview, books, observation, and academic journals etc.

V. SAMPLE SELECTION

For the purpose of comparison Survey has done in these two societies balkrishna society & sameer society with 10-10 samples of houses with solar panel or without solar panel. it is best suitable site for this study with its variable. It is a comparative analysis in the reduction in electricity bill between the houses with or without solar panel. Presents a survey of the solar water heating system and its benefits in reduction in energy consumption and also the various types of solar thermal collectors and applications. All the solar systems which utilize the solar energy and its application depends upon the solar collector such as flat-plate, compound parabolic, evacuated tube, parabolic trough, Fresnel lens, parabolic dish and heliostat field collectors which are used in these system these are internal factor but similarly there is an external factor like orientation of solar panel, adjacent building if it is casting shadow on solar panel, tall tree, further construction of building and shifting of solar panel, deposition of dust and dirt on solar panel etc.... which also effect on the efficiency on the solar panel and also there is some future aspect which can effect solar water heating system after some time of period. This survey is more focusing on external aspect.

Samples

At Bal Krishna society & Sameer Society

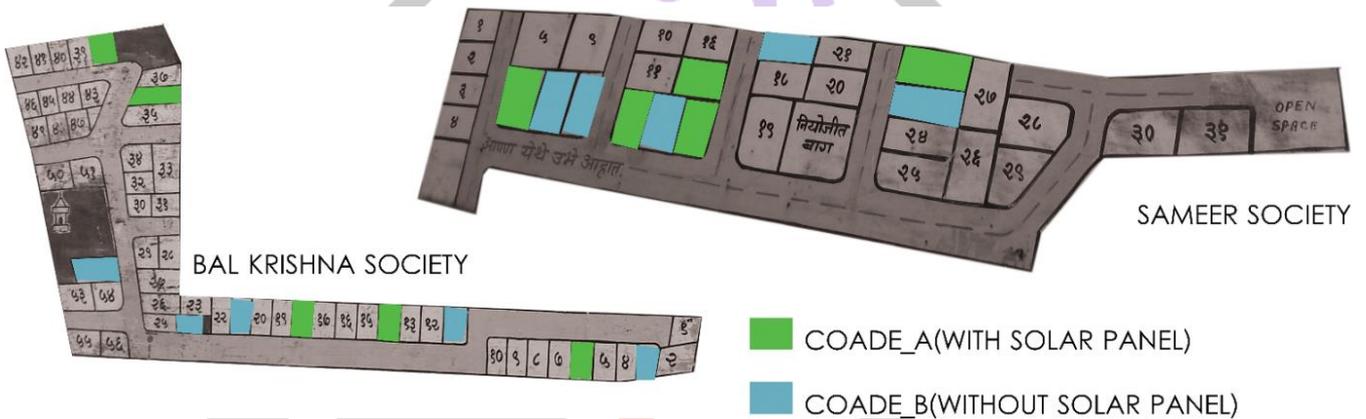
Figure 1 India Map



Figure 2 Bal Krishna Society and Sameer Society



Figure 3 Society Map



PARAMETER OF STUDY

WITH SOLAR PANEL HOUSES(code A)

1. year of installation.
2. installation charge.
3. company name.
4. electricity bill before installation solar panel/ after installation.
5. mode of heating water before installation of solar hot water system.
6. use of electrical appliances in bad weather conditions when solar system cannot work.
7. factor affecting on efficiency of solar system
 - orientation of solar panel.
 - adjacent building if it is tall & casting shadow on solar panel.
 - tall tree
 - further construction of building and shifting of solar panel.
 - deposition of dust and dirt on solar panel etc....

without solar hot water system (code B)

1. reason for not using solar hot water system
2. current electricity bill
3. use of electric appliances for heating water
4. electricity bill in different seasons

METHOD

A pilot survey was done followed by a questionnaire survey with 10-10 households in each case that took respondents approximately 15min each to complete. The survey questionnaire was developed after reviewing the literature assessing other relevant questions.

Observation method, Field observation was noticed to validate the answer provided by the respondents.

Interview method was used to ask more information about solar panel and to find out general awareness about solar hot water system. This survey data presents the benefit of solar water heating system and reduction in energy consumption and also the various types of solar thermal collectors and applications. All the solar systems which utilize the solar energy and its application depends upon the solar collector such as flat-plate, compound parabolic, evacuated tube, parabolic trough, Fresnel lens, parabolic dish and heliostat field collectors etc.

these are internal factor but similarly there are an external factor like. “orientation of solar hot water system , adjacent building if it is tall& casting shadow on solar hot water system, tall tree, further construction of building and shifting of solar hot water system, deposition of dust and dirt on solar hot water systematic.” Which also effect on the efficiency of the solar hot water system and also there is some future aspect which can effect solar water heating system after some time of period. This survey is more focusing on external aspect.

VI. ANALYSIS

Two societies Sameer Society and Bal Krishna society have been compared on the basis of the parameters of study.

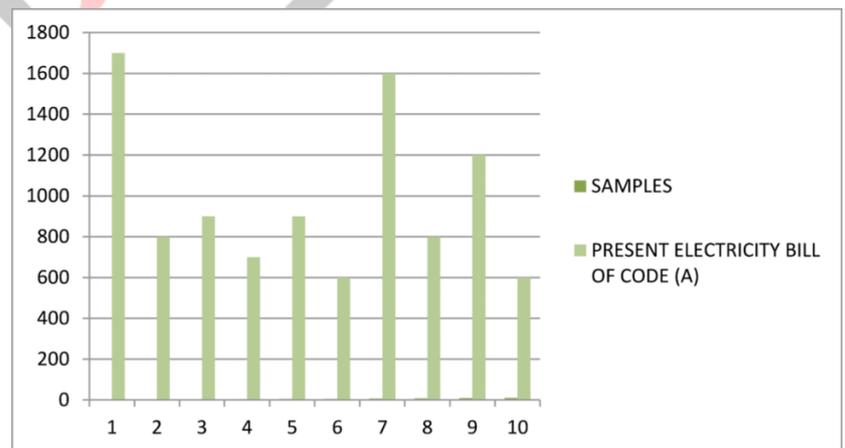
WITH SOLAR PANEL HOUSES(code A)

1. year of installation.
2. installation charge.
3. company name.
4. electricity bill before installation solar panel/ after installation.
5. mode of heating water before installation of solar hot water system.
6. use of electrical appliances in bad weather conditions when solar system cannot work.
7. factor affecting on effecency of solar system
 - orientation of solar panel.
 - adjacent building if it is tall & casting shadow on solar panel.
 - tall tree
 - further construction of building and shifting of solar panel.
 - deposition of dust and dirt on solar panel etc....

Table 1 Electricity bill of houses using solar hot water system

SAMPLES A	CODE (A)
1	1700
2	800
3	900
4	700
5	900
6	600
7	1600
8	800
9	1200
10	600

Figure 4 Electricity Bill graph using solar hot water system

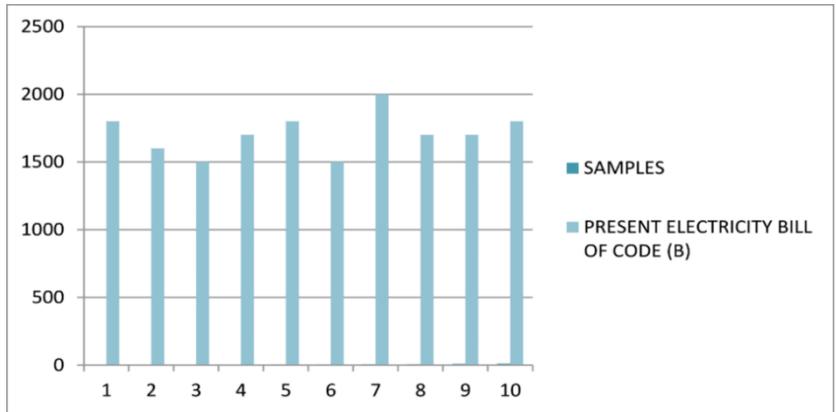


WITHOUT USING SOLAR HOT WATER SYSTEM (CODE B)

Table 2 Electricity bill of houses without solar panel

SAMPLE	PRESENT ELECTRICITY BILL OF CODE (A)
1	1800
2	600
3	1500
4	1700
5	1800
6	1500
7	2000
8	1700
9	1700
10	1800

Figure 5 Electricity bill graph without solar panel system

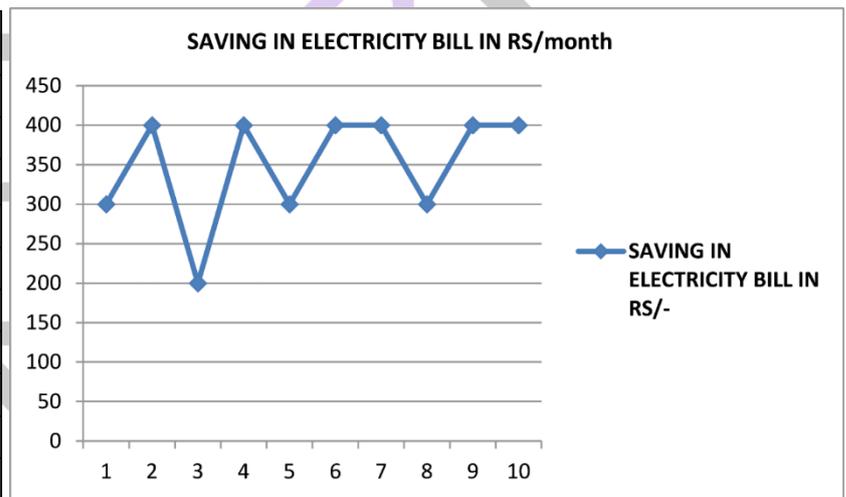


ELECTRICITY BILL AND SAVING IN WITH SOLAR PANNEL HOUSES (CODE A)

Table 3 Saving in electricity bill of houses without solar panel

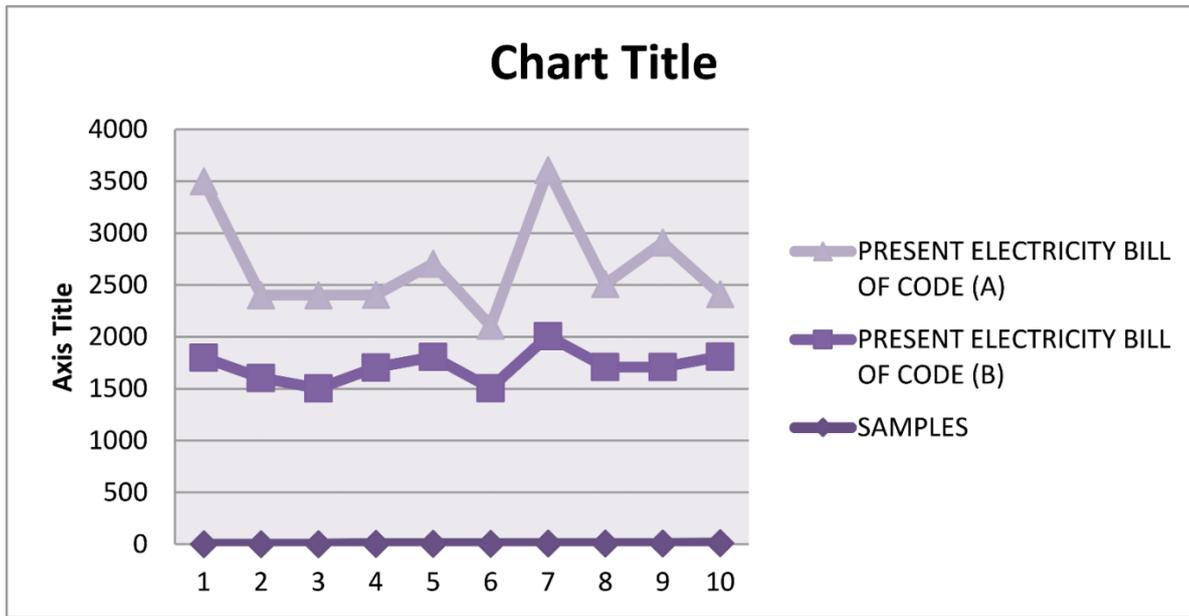
SAMPLES (A)	SAVING IN ELECTRICITY BILL IN RS/-
1	300
2	400
3	200
4	400
5	300
6	400
7	400
8	300
9	400
10	400

Figure 6 Saving in Electricity bill graph



COMPARATIVE ANALYSIS BETWEEN CODE A AND CODE B

Figure 7 Graph On comparative Analysis

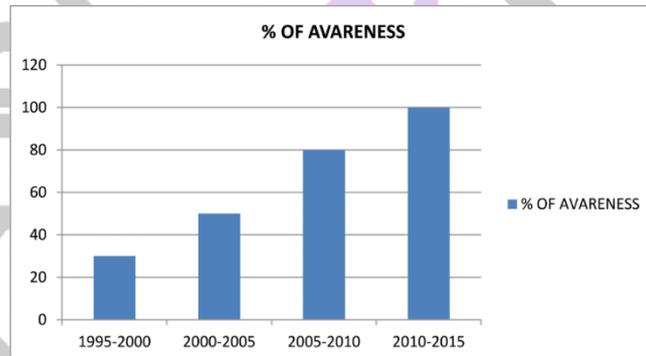


PERCENTAGE OF AWARENESS ABOUT SOLAR WATER HEATING SYSTEM

Figure 8 % of solar panel

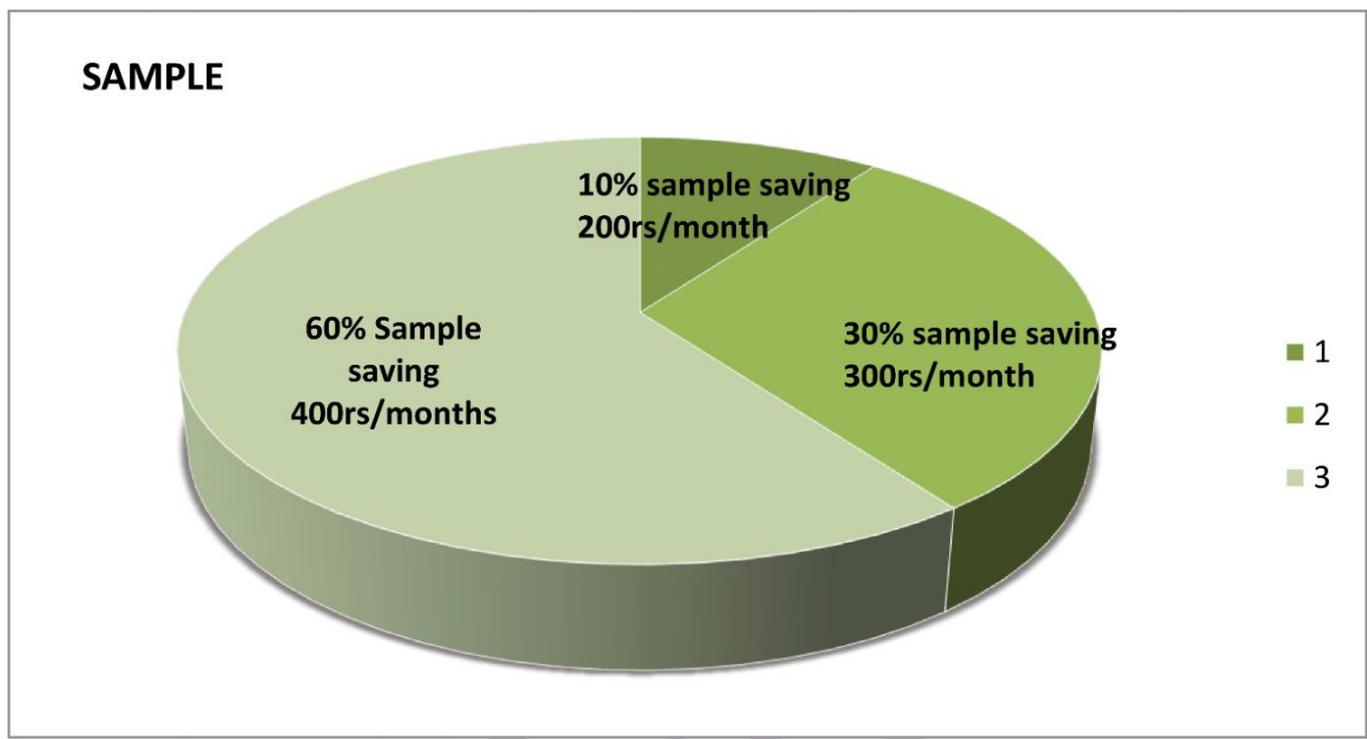
Table 4 Awareness about solar panel

YEAR INSTALLATION	OF	% OF AVARENESS
1995-2000		30
2000-2005		50
2005-2010		80
2010-2014		100



VII. CONCLUSION

By this study our final data, it says that 60% of house owners are saving Rs.400 per month in their electricity bill & there are other factors which are affecting on the efficiency of solar hot water system and reducing saving every month.



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