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Sustainable Energy Use for Solar Domestic Hot Water (SDHW) Systems

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Abstract — solar water heating system is the key element of green construction. Hence, this research is significant in order to help, both people and government, apply solar energy. The aim of this paper is to identify the current practices of solar water heating system in domestic buildings. Furthermore, to identify the factors that restrain the application of solar water heating system in domestic buildings. Hence, investigating the current practices of solar water heating. Moreover, this paper focuses on the current practices of solar water heating system in domestic buildings. The research is to identify the main factors that are affecting the application of solar water heating in domestic buildings. The result of the research can contribute new knowledge in the industry by identifying possible ways of implementing the solar water heating system techniques.

Keywords— Solar Domestic Hot Water (SDHW), Integral collector-storage (ICS), Evacuated Tube Collectors (ETC), Direct Circulation Systems (DCS).

I. INTRODUCTION

Solar energy is a clean and abundant energy resource that can be used to supplement several energy needs. Solar energy can be utilized as a form of heat, such as solar water heating, and as electricity, such as solar photovoltaic. Solar water heating systems are commonly referred to in the industry as Solar Domestic Hot Water (SDHW) systems. Water heating is one of the most cost-effective uses of solar energy, providing hot water for showers, dishwashers and washing machine. Every year, several thousands of new solar water heaters are installed. Water heating is an accepted technology and is increasingly being used as one of the cost-effective means of heating water in residential and public buildings such as hotels, laundries, restaurants, hospitals and health centers [1]. Solar water heaters can be a cost-effective way to generate hot water for homes. It uses sunlight as it energy source which makes it possible to be used in any climate. There are two types of solar water systems: active and passive [2]. Solar water heating (SWH) or solar hot water (SHW) systems comprise several innovations and many mature renewable energy technologies.

II. SOLAR DOMESTIC HOT WATER SYSTEMS

It is important to support the use of green energy instead of electric energy. Renewable energy sources appear to be one of the most efficient and effective solutions for sustainable energy development. This section focuses on the research approach, method and analysis of the data:

1. *Benefits of Solar Water Heating:*

Solar water heater reduces the amount of fuel needed to heat water. Because it captures the sun's light and use it as renewable energy. Many solar water heaters use a small

solar electric (Photovoltaic) module to power the pump [3]. The pumps needed to circulate the heat and transfer fluid through the collectors. The use of such module allows the solar water heater to operate even during a power outage. Solar water heaters can also be used in other applications. Such as, car washes, hotels, restaurants, swimming pools, and Laundromats [4]. Using the sun's energy to heat water is not a new idea. More than one hundred years ago, black painted water tanks were used as simple solar water heaters in a number of countries [5]. Solar water heating technology has greatly improved during the past century. Solar heaters, or solar thermal systems, provide environmentally friendly heat for household water heating, space heating, and the heating of swimming pools. Such systems collect the sun's energy to heat a fluid. The fluid then transfers solar heat directly or indirectly to your home, water, or pool (Renewable energy technology deployment). A schematic diagram of solar thermal water heating system is shown in Figure 1. In addition to the existing conventional hot water heater, the main components are: a solar collector panel, an insulated storage tank, and a heat exchanger. [6]. Figure 1 shows a small electric recirculation pump powered by a photovoltaic (PV) panel. The advantage of such a system is that it does not rely on external energy for operation. However, the pump can be powered by any means, and often, large scale installations require much larger units than a PV panel to power it [1].

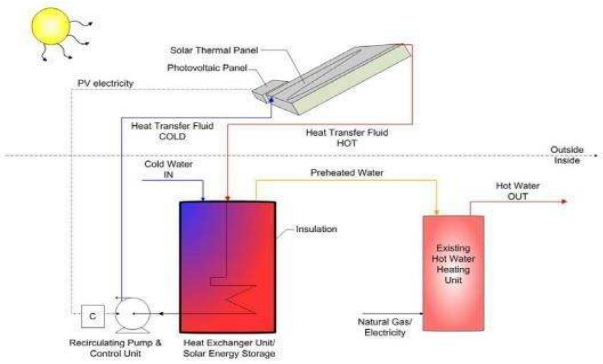

Fig 1. Schematic Diagram of a Solar Thermal Water Heating System [1].

2. *Types of Solar Collectors Used for Residential Applications:*

• Flat plate collectors (FPC) based solar water heaters: In this type, the solar radiation is absorbed by Flat Plate Collectors which consist of an insulated outer metal box covered on the top with glass sheet, as seen in figure 2.

Fig 2. FPC Based SWH System [4].

• Integral collector-storage (ICS) systems: Also known as batch systems. They feature one or more black tanks or tubes in an insulated, glazed box. Cold water first passes through the solar collector, which preheats the water. The water then continues on to the conventional backup water heater.

• Evacuated tube collectors (ETC) based solar water heaters: Evacuated Tube Collector is made of double layer borosilicate glass tubes evacuated for providing insulation, as seen in figure 3. This helps in absorbing the solar radiation and transfers the heat to the water [7].

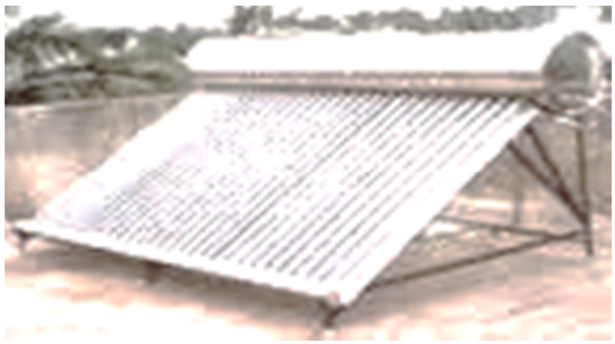

Fig 3. ETC Based SWH System [2].

3. *Types of Solar Water Heating Systems:*

Solar water heating systems include storage tanks and solar collectors. There are two types of solar water heating systems:

• Active solar water heating systems:

A- Direct Circulation Systems (DCS): pumps circulate household water through the collectors and into the home.

B- Indirect circulation systems: Pumps circulate a non-freezing, heat-transfer fluid through the collectors and a heat exchanger. This heats the water, which then flows into the home, as shown in figure 4. They are popular in climates

prone to freezing temperatures [7].

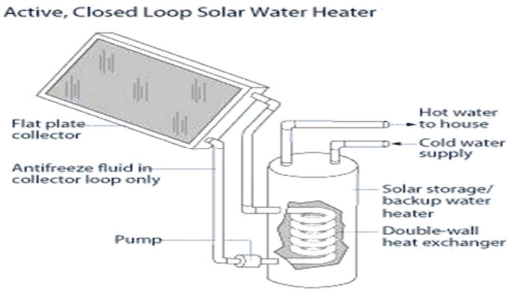

Fig 4. Active Solar Systems [7].

• Passive solar water heating systems: These are typically less expensive than active system, but they're usually not as efficient. However, passive systems can be more reliable and may last longer. There are two basic types of passive systems:

A- Integral collector-storage passive systems: These work best in areas where the temperature rarely falls below freezing. They also work well in households with significant daytime and evening hot-water needs.

B- Thermosiphon systems: Water flows through the system when warm water rises as cooler water sinks. The collector must be installed below the storage tank so that warm water will rise into the tank, as shown in figure 5. These systems are reliable, but contractors must pay careful attention to the roof design because of the heavy storage tank. They are usually more expensive than integral collector-storage passive systems. Solar water heating systems almost always require a backup system for cloudy days and times of increased demand. Conventional storage water heaters usually provide backup and may already be part of the solar system package [7].

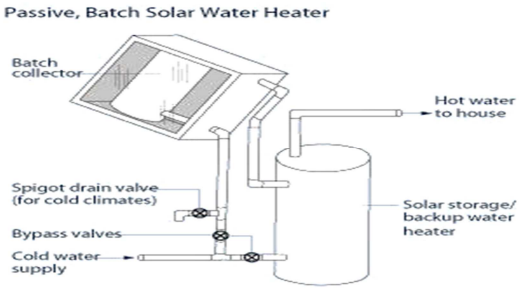

Fig 5. Passive Solar Systems [7].

4. *Components of Solar Heater*:

Solar water heater is a combination of items depending on the type of design. In general, it consists of three main components, as seen in figure 6:

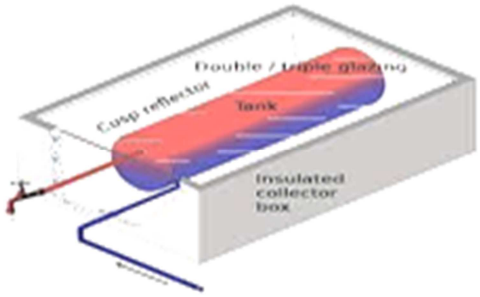

Fig 6. Components of Solar Heater [8].

A- Solar collector, which converts solar radiation into useable heat.

B- Heat exchanger/pump module, which transfers the heat from the solar collector or into the potable water.

C- Storage tank to store the solar heated water.

5. *Incident Solar Irradiation:*

Solar irradiation is the total solar radiation reaching the plane of the collector. It can come from the beam, diffuse and ground reflected radiation. The first step in the design of any solar thermal system is the determination of the solar resource available in the location where the system will be installed. The daily and monthly average values of the incident solar irradiation in the plane of the collector can be determined by using the Liu and Jordan isotropic sky model approach [8].

6. *Estimating Hot Water Load:*

Determining the hot Water load is to estimate the daily energy required to heat water. It is calculated from the average gallons of hot water required per month, and the rise in temperature from the cold water mains to the output temperature of the system [10].

III. Conclusion

The solar radiation incident on the surface of the earth can be conveniently utilized for the benefit of human society. One of the popular devices that take advantage of the solar energy is Solar Domestic Hot Water (SDHW) systems. The main aim of this study is to investigate the factors that influence the application of Solar Domestic Hot Water (SDHW) systems. As many countries are planning to implement green materials in their construction, this paper considers the application of solar water heating system, which is considered one of the green materials in the

construction industry. Moreover, this paper suggests possible ways that can promote their usage to reduce the dependency on outside electricity sources. Environmental concerns have made domestic SWH systems a positive status symbol. Furthermore, it helps reducing air polluting emissions, reducing dependency on energy imports, reducing the use of fossil fuels or nuclear power hence reducing for electricity demand.

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