Base on solid-works design of compact high efficient solar water heater.

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Abstract: – A solar water heater is a type of heating system that uses solar energy from the sun to heat water for domestic, industrial, or commercial use. It typically consists of a solar collector panel or array, a storage tank, and plumbing or circulation systems. The solar collector panel absorbs the energy from the sun and transfers it to the water in the storage tank. The heated water can then be used for various purposes, such as showering, washing, or space heating.

A solar heating system, on the other hand, is a more general term that refers to any type of heating system that utilizes solar energy. This can include solar water heaters, but it can also include other systems, such as solar space heaters, solar air heating systems, or solar-assisted heat pumps. Solar heating systems can be used in residential, commercial, or industrial settings and can be integrated with existing heating systems to provide a renewable energy source and reduce reliance on fossil fuels.

Key-Words: - Solar Water Heater, Solar Water Heating system
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1 Introduction

The Sun produces a tremendous amount of energy that could potentially meet the energy requirements of our planet, but extracting energy from it has been difficult compared to fossil fuels or nuclear power. Solar energy has been effective in producing electricity and heat, and solar hot water systems are popular due to their low cost and ease of maintenance. The goal of a thesis on this topic is to create an efficient hot water system that utilizes natural resources and reduces electricity consumption. One way to increase efficiency is to provide proper insulation to reduce heat loss.

The use of solar energy for water heating is an effective and natural technology that can help reduce reliance on fossil fuels. Solar water heaters can be active or passive, and their performance depends on the availability of solar energy and the temperature of incoming water. Photovoltaic thermal technology combines PV cells and thermal collectors to generate both thermal and electrical energy. Using Al2O3 and MWCNT water Nano fluids as working fluids can significantly increase the efficiency of flat plate solar collectors. Hybrid domestic hot water systems that combine with thermo-electric air conditioners can also be effective. However, the thermal efficiency of solar water heaters may be reduced in winter due to lower temperatures and less solar radiation.

Solar water heating systems are a popular choice for household and swimming pool water heating because they are environmentally friendly and use energy from the sun. There are two types of solar collectors, with evacuated tube collectors being the most efficient. Researchers have focused on improving and measuring heat transfer losses in both types of collectors. The cost of solar water heaters has decreased in the last ten years, with prices

ranging from $800 to $10,000. The paper aims to investigate the efficiency and cost analysis of solar water heaters.

The world is facing harmful effects from conventional energy sources and an increasing demand for energy due to population growth. Therefore, renewable energy sources have become a priority, particularly in fields such as solar water heating. There have been many innovations in the design of solar water heaters, and this study focuses on a modified design of a flat plate collector for water heating. The study uses the Hottel-Whillier-Bliss equation and the Annual Worth method to determine thermal performance and economic impact. The study covers four countries, looking at their climates, and suggests that the modified design could be successful in improving efficiency and cost optimization. Finally, the study includes information about the climates of China, Sweden, Liberia, and Malaysia.

Solar water heating is a technology of capturing the energy from the sun's radiation for the purpose of raising the temperature of water from water supply temperature to the desired higher temperature depending on the use. There are many views and discussions on the questions of thermal efficiency of solar water heaters and their associated cost, especially different customers/users want to replace their existing conventional water heating energy by solar water heating systems. In this paper, a deep investigation has been accomplished to determine thermal efficiency and cost analysis of solar water heater which can be used in Liberia specifically and other parts of the world. The humid, tropical climate in Liberia shows relatively constant temperatures throughout the year, around the average of 27° C (81° F), hardly ever outside the range of 20° C (68° F) to 36° C (97° F). In Liberia, monthly solar radiation on horizontal surface ranges from about 4 kWh/m^2/day during the rainy season in June, July, and August to 6 kWh/m^2/day during the height of dry season in February and March. This high and consistent potential for solar energy across the country adds to an average level of 1,712 kWh/m2/year, which could generate 1,400 to 1,500 kWh/kWp.

According to the World Bank Fact book (CIA) electricity consumption is about 39 million kWh (2016 est.) Based on a 2014 household survey, only 4.5% of Liberian Electricity Cooperation (LEC) power. 4.9% used community generator current,4.4% have their own generator,3.9% used vehicles batteries,0.8% used other sources of electricity.

81.3% have no access to electricity. LEC accounts for roughly 70 million kWh of output (2016 est.) 9.1% of the population have access to electricity,16.8% of Urban population, and 1.7% of Rural population (World Bank 2014 est.)

Energy consumption in Liberia is dominated by biomass with a shear of more than 80% of the used primary sources. Most important is woody biomass used for domestic cooking and heating. In 2004, it was estimated that over 95% of its population depended of firewood and charcoal for cooking and heating needs and palm oil for lighting. Most recent census (2008 data, published in 2009 by The World Bank) shows that 70% of the urban population used charcoal for cooking and 5% of the rural population; 91% of the rural population used firewood for cooking and 21% of the urban population. In Monrovia, the percentage of households using charcoal is even higher, 85%. Around 2% of the population have access to clean fuels and technologies for cooking etc. (World Bank, 2014). With this my research which is aimed at providing solutions to the many electric energy problems in Liberia and other parts of the world, I hope to have this my model which is environment friendly and less cost effective to meet up with such demands of Liberia and the World at large. Similarly, this

modified design of the solar water heater is expected to achieve around 5% more thermal efficiency than the previous designs. The thermal efficiency has been found to decrease rapidly when the ambient temperature increases.

Since the Third Industrial Revolution, human society in economy and technology has developed unprecedentedly but a series of problems have arisen at the same time. One main problem is energy shortage due to the conventional energy structure which relies on large supply of fossil fuels. As shown in Fig.1 the world energy consumption by fuel from the year 1870 to 2030, fossil fuels, as well known as Coal, Oil and Gas, are the dominant energy sources till today.

The world's primary energy consumption is expected to increase by 1.6% annually by 2030, and total energy consumption is predicted to double by 2050 compared to 2005. However, the world's conventional fossil fuel reserves are limited and cannot meet the increasing energy demand. Excessive consumption of fossil fuels also leads to long-term environmental problems such as global warming. Therefore, the conversion to renewable energy, particularly solar energy, is essential. Despite only a small fraction of solar radiation reaching the Earth's surface, solar power is abundant, inexhaustible, and clean.

The power from the sun intercepted by the Earth is many times larger than the present rate of all energy consumption, and solar radiation is the principal source of much renewable energy. Solar thermal technologies are regarded as the most economical way of utilizing solar energy, and their history can be traced back to ancient times. The manufacture of solar water heaters began in the early 60s and has developed into a largely mature market worldwide. Solar collector technologies are necessary to concentrate solar radiation for utilization.

Solar collectors are essential components in solar energy systems that absorb solar radiation and convert it into heat to be transferred to a working fluid. They can be classified based on various criteria, with flat plate collectors and evacuated tube collectors being the most widely used. Flat plate collectors are simple, cost-effective, and can collect as much solar energy as possible, while evacuated tube collectors are ideal for high-temperature operation and have low heat losses and high durability. Both types of collectors are used in various applications, such as solar water heating, solar space heating and cooling, solar reAt the end of 2012, the global solar hot water capacity was approximately 282 GWth, with glazed water collectors accounting for 255 GWth. China and Europe have the highest market share for all types of collectors, and solar hot water collectors are used in over 56 countries for various applications. China is the biggest producer and seller of solar water heaters and has become a leader in the solar thermal market. The paper discusses the condition of SWHs market in China, including the types of SWHs, their prices, and why evacuated SWHs are popular. The paper also examines the Swedish market and its policies in renewable energy, which can help to understand the impacts and trends of the whole European market.frigeration, and solar thermal power systems.

2 Problem Formulation

This research focuses on the design of a modified solar water heater system using a flat plate collector that achieves higher thermal efficiency and lower costs. The research is aimed at providing sustainable and renewable energy solutions to countries such as Liberia, China, Sweden, and Malaysia that have faced challenges in meeting their energy demands. The modified design is expected to achieve 5% more thermal efficiency than previous designs, with a low daily collector heat loss and a calculated payback period of 5 years, making it economically advantageous for residential buildings.Solar water heating is the process of

using solar radiation to increase water temperature. The efficiency and cost of this technology are often debated, particularly among those looking to replace traditional water heating methods.

2.1 Objectives

The objectives of this design are to: 1) increase the efficiency level of a solar hot water system by reducing heat loss and using renewable energy, 2) work on insulation to minimize temperature drop overnight, 3) increase system efficiency to utilize it fully, and 4) use different types of insulating material and measure irradiance with a pyrometer.5. to increase its efficiency level by reducing heat loss, 6)to work on insulation at variable time, temperature, and solar radiation, 7)to use different types of insulating material and measure its irradiance with a pyrometer, 8)to identify the operating optimum temperature, 9)to be environmentally friendly and widely used in residential buildings, 10)to meet economic demands, 11)to be easy to maintain with a simple design, and 12)to make a meaningful difference to the growth and development of Liberia and the world's energy demands and economies.

11. Identify potential technology pathways and cost/performance targets that must be met to enable SWH systems to achieve large energy savings.

2.1.1 Description of the system

This system uses a 150 liters solar collector and a 300 liters storage tank to store water. The optimum temperature for storing water in the tank has been analyzed, and the loss of temperature is noted. The system uses steel pipes coiled together and a metal plate with black paint to absorb solar rays, along with two reflective sheets to gather and reflect additional rays. The system heats up the pipes and water passing through them, which can be used through a third outlet. This efficient solar water heater saves over 99% energy and provides warm water instantly.

The solar hot water system has an operating temperature of the outlet water from the storage tank, and if it cannot meet the desired temperature, an electric water heater is used. The system is driven by a microcontroller and uses thermostat technology to reduce costs. PV systems require components such as solar modules, charge controller, battery, inverter, lightning protection, storage tank, and mounting frame. These components convert sunlight into electricity, regulate voltage and current, store electricity, convert DC power into AC power, protect equipment from lightning, and hold the PV solar collector.

Basically there are two types of solar thermal collectors that are used in such system: evacuated tube collector and flat plate collector. Efficiency per unit area of evacuated tube collectors at low temperature can exceed that of flat plate collectors and the difference in performance becomes more significant as the average 10 operating temperature increases.

3 Problem Solution

The objectives of this design are to: 1) increase the efficiency level of a solar hot water system by reducing heat loss and using renewable energy, 2) work on insulation to minimize temperature drop overnight, 3) increase system efficiency to utilize it fully, and 4) use different types of insulating material and measure irradiance with a pyrometer.5. to increase its efficiency level by reducing heat loss, 6)to work on insulation at variable time, temperature, and solar radiation, 7)to use different types of insulating material and measure its irradiance with a pyrometer, 8)to identify the operating

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4 Conclusion

Taken into considerations the existing situation into the energetically field, it is foreseeable that an alternative energy sources will become more and more charismatic and remarkable part played into this project to be achieve through the use of solar collector. It has been seen that the regions where the sun radiation is high, the performance of both collector and tank is also good.

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