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DESIGN AND DEVELOPMENT OF A COST EFFECTIVE PORTABLE SOLAR PVT PLANT FOR RURAL AND TRIBAL VILLAGES

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Abstract - *A Novel research and development work on the photovoltaic/thermal (PVT) technology has been done so far to design many innovative products and systems for a wide range of different applications, which includes industries, agriculture and residential purposes. This proposed design is fully dedicated to rural and tribal village people, to fulfill the demand of their day to day needs and remove the barriers of their health as well as wealth issues with appropriate user friendly control technology in a reasonable cost. This design is the combined feature of PVT application.*

Key Words: **photovoltaic/thermal, Thin Film Structure, Battery, Copper Tube**

1.INTRODUCTION

A photovoltaic/thermal hybrid solar system is a combination of photovoltaic (PV) and solar thermal components/systems which produce both electricity and heat from one integrated component or system [1]. There are alternative approaches in PVT integration techniques. There may be selections among air, water or evaporative collectors, monocrystalline/polycrystalline/amorphous silicon or thin-film solar cells, flat-plate or concentrator types, glazed or unglazed panels, natural or forced fluid flow, standalone or building-integrated features, etc [2]. Accordingly, available installations are ranging from PVT air and/or water pre-heating system to hot water supply through PV integrated heat pump, and to actively-cooled PV concentrator through the use of economical reflectors. Design decisions have to be made on the collector type, the thermal to electrical yield ratio, as well as the solar fraction for optimizing the overall benefits. These all have determining effects on the system operating mode, working temperature and efficiency.

A significant amount of research and development work on the PVT technology has been conducted since 1990 with a gradual increase in the level of activities. But real project applications are still limited at this stage. This article gives an eye opener in development of this technology. PVT technology is popular in large scale applications but while think about small scale applications still it is only in starting phase.

Nowadays the dependency on renewable sources of energy is increasing due to the decrease in fossil fuels and increase in emissions of greenhouse gases. In this paper we are using the solar energy to light a led lamp and for heating of water. This facility will be of immense help in the rural area. In India significant section of rural areas do not have any access for lighting and still use kerosene lamp which apart from increase in greenhouse gas affects human health.

This is to use the solar energy for simultaneously to generate electricity which is proposed to be used to lighting purpose and use some space to heat water which can be used for multi purposes. The pilot project has been developed by using materials that are readily available in the market. This work is only a pilot project and further studies with respect to improving design to enhance efficiency and use of materials which are economical needs to be done in the next scale up.

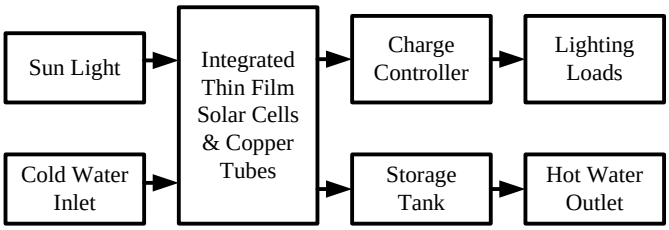

Fig -1: Block Diagram of the proposed System

The above stated block diagram expressed the clear view about the proposed system. It performed two types of actions. One is the freely available solar radiation will be converted to the electrical energy with help of thin film solar cells, this generated electrical energy is used for lighting loads of the rural and tribal villages of India. The second option is that the cold water will be converted to a hot water with help of readily available copper tubes. One family may get nearly 4 to 5 liters of hot water per day; the idea behind the hot water generation is to reduce the dependence on

wood materials which is used for their day to day cooking purpose, in case it will applied to large scale means this will reduce the carbon di oxide generation which will indirectly help to reduce the global warming.

Many villages in India are not connected with the electricity grid. So, photovoltaic (PV) technology transfer itself not enough to meet their demands, countries like India is having more solar insolation. It is very much essential to transfer this PVT technology to rural and tribal villages, because this design will deliver wide range of applications not only to store and use the electrical energy and also one will get the hot water with suitable storage and control technique.

This is a pilot project that can be used for further development to increase the use and feasibility of the energy and further increase the efficiency. A scaled up model of this design would increase the heating and lighting efficiency and will help improve quality of life in rural area.

2. PROPOSED METHODOLOGY

The project proposes to use the solar energy effectively to light a 7 watt led lamp and heat up 2 liter (approximately) of water simultaneously. To achieve this task we require 20 solar panels of 4V & 100mA and 10 solar panels of 4V & 200mA. Each of 5 solar panel is connected in series to give a voltage of 20V. Then each row of these 5 panels must be connected in parallel to produce a current of 800mA. Here a battery is used for storing the energy. The gap between each solar panel is provided with copper tube for the water to pass. The copper tube is also arranged in a serpentine shape and is to be placed in a transparent glass cylinder to maximize the heating effect. This tank is otherwise called as multipurpose storage tank. This is used to store the heated water and to make the stored water further heating.

The PVT technology also produces the following benefits that help to enhance the payback period

- Proposed system addresses the majority of un electrified village energy requirements, which is both heat and electricity requirements.
- Huge reduction in greenhouse gas emissions.
- Replacing the heating load is typically a direct source reduction from CO2 because the fuel being displaced is usually natural gas or heating oil.
- Allows for the production of two types of solar energy from one work pad.

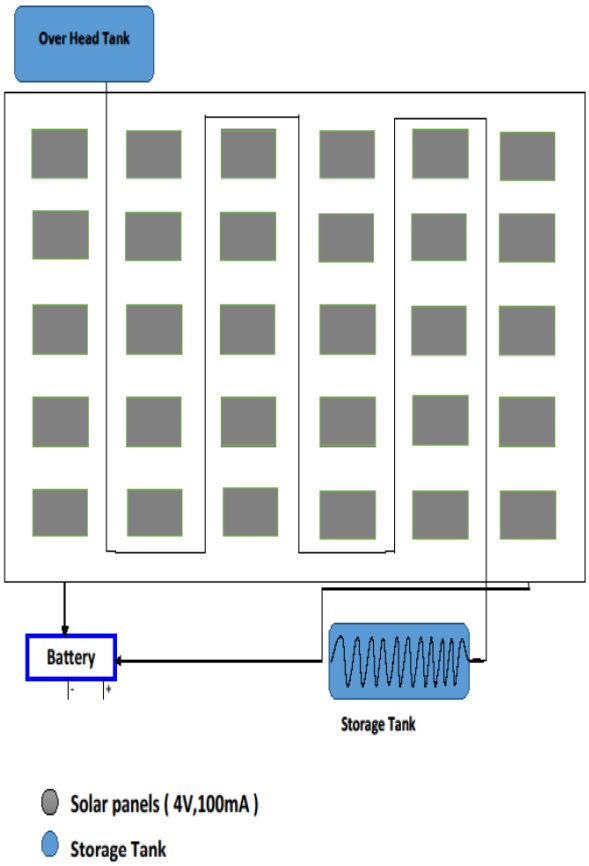

Fig -2: Arrangement Diagram

3. CONSTRUCTIONAL FEATURES

3.1 Multipurpose Storage Tank

Multipurpose tank is used to store the water as well as heat the stored water; it is specially designed for this purpose. Inside that tank copper tube is placed in a serpentine manner to further enhance the heating function. The storage tank also absorbs the sunlight directly, so dual heating is taken place in that storage tank.

The main attributes of this storage tank is it always absorb the sunlight into the tank and it will never relief any heat to outside environment. So, the cumulated heat is always present in the storage tank even after sunset. After the utilization of heat water the cold water will came into the storage tank, it is a simple cost effective automated procedure. Hot water outlet is fixed in the top of the storage tank and the cold water inlet is placed in the middle of the

storage tank. So the upper portion is always filled with a hot water meanwhile it is always absorbs the sunlight too. Due to its low viscosity it is floating over the cold water. This total phenomenon makes the storage tank function as an automated one. Copper tube also a good heat absorber as well as it provides some goodness to the mankind. The multipurpose storage tank is shown in the following figure.

Fig -2: Multipurpose Storage Tank

Normally in domestic water heaters the storage tank is placed in a closed surface but here it is placed in an open environment. Though it is directly connected to an outside environment it will never omits any heat to the outside environment. But it will always absorb the external heat into the storage tank. That is why it is called as cost effective multipurpose storage tank. The quality of plastic material is also quit well and it will never give negative effect to the mankind.

3.2 Hybrid Solar PVT Pad

The Hybrid solar PVT pad comprises of solar photovoltaic panel for generating electrical power as well as copper tubes for making cold water into hot water. The arrangements of solar PV panels and copper tubes are clearly explained in the arrangement diagram itself. It is also shown in the following figure. Solar radiation which we receive as heat and light can be converted to useful thermal energy or for production of electricity either through solar photovoltaic route or through solar thermal route. Availability of reliable solar radiation data is vital for the success of solar energy installations in different sites of the country. From that hybrid solar PVT power plant a common un-electrified village can fulfill their basic needs in terms of electrical and thermal energy with a reasonable cost. By upscaling the system in terms of efficiency and usable material definitely it will become successful in fulfilling the rural and tribal village people day to day needs without spending much cost.

Fig -3: Portable Solar PVT power plant

Table -1: System Specification

Sl. No	Item	Specification	Quantity
1.	Solar Panel	4V,100mA & 4V,200mA	20 10
2.	Copper pipe	¼ inch	8m
3.	Battery	24V	1
4.	Acrylic Board	-	1m x1m
5.	Base Stand	-	1
6.	Tank	2L	1
7.	LED Lamp	7 watt	1

Regional language based IVRS (Interactive Voice Response System) in Hindi and Tamil can be developed and integrated with this system, so that even less educated people can remotely check the status of the system in their own language. They can also start/stop the water and electrical energy outlet remotely. Hence this can be monitored, even if absence of people nearby.

4. CONCLUSIONS

The proposed low cost high efficient ready to use design will definitely satisfy their demand in electrical as well as thermal energy is concern. The measured output from the proposed design also proves the feasibility and effectiveness of the system. 30% to 35 % of waste energy can be utilized by using the same solar panel. The objective of this work is to help in providing lighting and hot water with minimum or no pollution for people residing in the rural and tribal village area where the electricity is not available. This would improve the condition of the rural people in many aspects.

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