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Zero Energy Building achievement by inclusion of Photovoltaic System and Solar Thermal Technologies: A Review

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ABSTRACT:
Buildings, in all over the world are silent energy guzzlers. For the purpose of heating, cooling and other requirement, 40% of total energy of the world is consumed only by buildings. 1/3rd of Green House Gases are emitted by buildings, hence thereby for the reduction of energy consumption and Green House Gas , we have focused on Renewable Energy in which Solar Energy based systems are preferred because of abundant and easier availability of Solar Energy. This paper reviewed Solar Water Heating Technology , Solar Cooling System, Standalone Photovoltaic System and Grid Connected PV system. In this paper fundamental component of Solar Water Heater and the types of Solar Cooling system is presented. In order to fulfill the remaining demand of energy standalone PV system and Grid Connected PV systems are discussed with their components.
Keywords: Zero Energy Building(ZEB), GHG (Green House Gas) ,Solar Water Heating System(SWHS),Photovoltaic System (PV System), (SWCS) Solar Water Cooling System , Flat Plate Collector (FPC), (EFPC)Evactuated Flat Plate Collector , Coefficient Of Performance(COP).

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I. INTRODUCTION:

A net ZEB is defined as residential and mercantile buildings that detract energy needs by means of enhancing efficiency such that setting up the balance of energy requirement can be recoupmented with renewable technology [1]. In 1998, Lamp and Zieger reviewed the contents related to literature on solar desiccant cooling systems and investigated that solar assisted air conditioning systems were inexpensive in comparision of traditional cooling system [2]. M.Missoumet al. investigated energy performance of solar water heating system in climate condition of Algeria with too different prototypes of the storage tanks (i) fully mixed tanks and (ii) stratified tank[3]. Yusuke Yoshida et al. investigated performance of PV and SWHS for the verification of consumer's benefits in 10 regions of Japan for different conditions of weather[4]. Zakariya Rajab et al. has studied Technical and Economical feasibility of Domestic Solar Water Heaters in Libia over 5000 houses[5]. Mohamed A.Eltawil,et al. has reviewed the technical & potential problems for the reliability of Grid connected PV system[6]. Asmaou Adam et al. studied the use of stand-along photovoltaic system for electrifying a village of a Cameroon (Africa) covering the load of water pumping for agriculture and domestic purposes[7]. The monitoring procedures of Net ZEB definition have the main goal of calculating the balance including with the definition of Net ZEB [8].

II. SOLAR WATER HEATING SYSTEM:

This device include tubes or panels which collect the radiation energy from the sun for producing hot water.. An insulated tank is used to store hot water for using in mornings in routine[9]. The collector of SWHS collects the solar energy of sunlight and convert it into heat which produce hot water which is further stored within storage tank . For the surety of water being hot for all the time, the storage tank should be definitely insulated well for avoiding the heat loss [10]. In the whole process of heating the water, solar energy is firstly consumed by the absorber panel which is coated with selected coatings and this coating after converting this energy into heat it is transferred to the riser pipes which is beneath the panel. Then the water is passed through the riser for heating up and after that it is channeled towards the storage tank. If high temperature water is needed then it is recirculated by the absorber panel of collector and this process can result the temperature up to 80^{0}C in enough sunny day. The combination of these equipment like solar collector, storage, pipeline and storage tank make the whole solar water heating system. SWHS using today constitute the cylindrical glass tube which receive solar energy and the copper coil established within a glass tube inside of which water flows and it works as collector [11]. The heating occurs when working fluid comes in contact to the dark surface which highly absorptive and placed under sunlight[12]. This fluid may be water which is to be heated and this system is caslled direct system or at the place of only water there may be used heat transfer fluid (like water mixture or glycol) which is passed by means of some specific type of heat exchanger and this is known as indirect system. Theses system may be understood by two main classification: active system and passive system[13] shown in Fig.1.

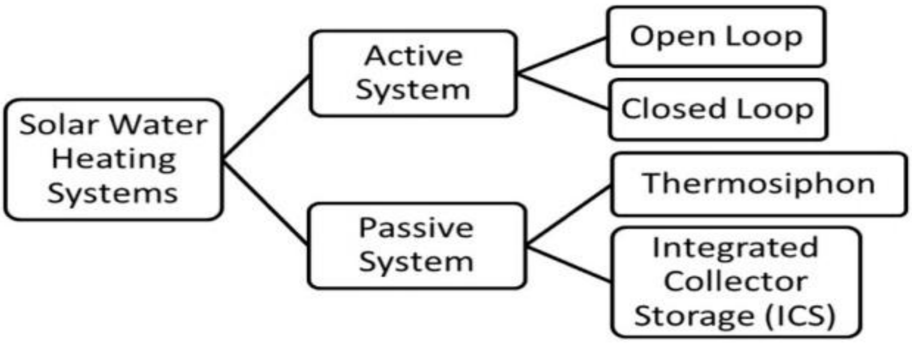

Fig.1: Solar Water Heating System [14]

i. **Active System:** Active system is used in almost all temperate climates as solar water heating system which use the pumps for circulating the heat transfer fluid. This system generally uses flat plate or evacuated tube collector that absorbs both the direct and diffused solar radiation and it works even of clouded weather [15]. As soon as the difference between water temperature of tank bottom and the temperature of the heat transfer fluid at collectors outlet exceed a preset value. This is the fluid with special properties like high boiling and low freezing point. Because of easy operation and lower cost these are convenient for the application of low temperature as below 80^0C. an auxliliary heating system may be used for raising the temperature of water when less heat is attend from solar collector[16].

ii. **Passive system:**The passive systems use natural convection method for heat transfer and it does not use any mechanical device for circulating the water [17] or heat transfer fluid from collector to storage tank because of being tank below from the collector[18] as shown in fig2. In this system fluid density is decreased after getting heated gradually. In the collector (usually flat plate collector) after collecting radiation energy by collector from the sun fluid absorbs the heat and its density decreases upsurge to the top of the collector and from there it is extracted and collected to the storage tank. When sun is not available the fluid will be cool down and is turned to the bottom of the storage tank and recirculate toward the collector.[13]

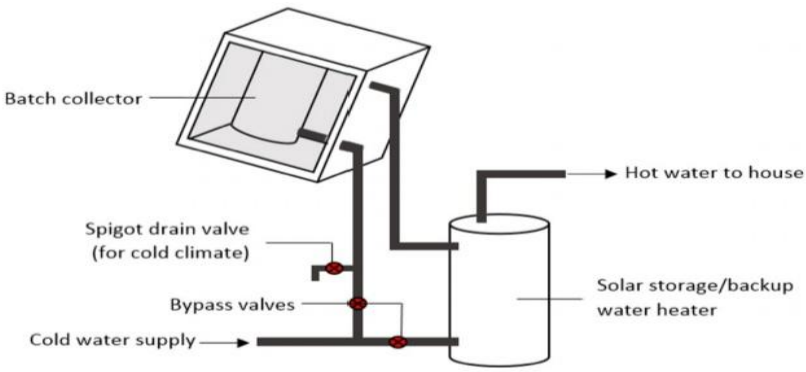

Fig.2: Passive Solar Heating System [14]

iii. **Thermosyphon:** It consist of flat plate collector mounted on roof, storage storage tank for hot water and connecting pipes together[19]. The process of thermosyphon occurs as soon as the density of water ein the collector decreases and it expands due to heat gained from solar through collector's header to the top of storage tank. After the upsurging of hot water to the top of storage tank the cold.

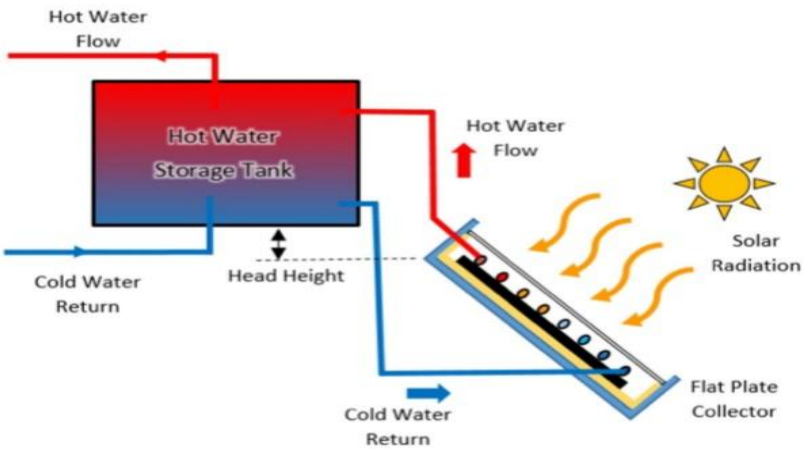

Fig. 3: Thermosyphon [14]

iv. **.Integrated collector storage:** An other example of passive system is Integrated Collector Storage (ICS), which combine the solar radiation collector and the storage tank incorporated both in single unit[21].
Solar Water Heaters have many fundamental components such as collector panel of solar radiation, heat transfer fluid and storage tank shown in fig4. Some eother additional components for example auxiliary heater, heat exchanger, pumps (used for active system) and piping units also come along SWSH [22].

i. **Solar collector:** It works as a heat exchanger by which the solar radiation energy is transformed into internal energy of transported medium, where it absorb impinging solar radiation to convert it into thermal energy and transfer the heat energy to the fluid (generally water, air or oil) being flowed within collector.[23]

ii. **Storage tank:** it is the system where thermal stratification is applied gradually for consuming adequate heat energy [24].

iii. **Heat Transfer Fluid:** the purpose of heat transfer fluid is consuming heat from collector and after that transferring it to storage tank by heat exchanger by direct or indirect method. Ther are many types of heat transfer fluid using today like water, silicon oil, glycol mixture and hydrocarbon oils[13].

III. SOLAR COOLING SYSTEM:

Solar cooling systems is classified in electric system and thermal powered system. The electric system convert the solar energy into electrical energy by using PV cells and then this electrical energy is utilized for generation of cooling power by use of old conventional methods. The solar thermal cooling systems which provide cooling energy by direct using solar energy, are mainly classified as; absorption cooling system, adsorption and desiccant cooling system. These systems operate by using the harmless refrigerants[25]. The key components of which the solar thermal cooling system consist are; solar collectors, thermal storage tank, condenser, evaporator, heat exchanger, expansion valve and refrigeration chamber[26].

Michal Masaryk et al.have dealt with solar power ejector cooling system's design and found the result that an availability of cheaper and reliable heat source such as solar can make them promising solution for air conditioning of building but with a disadvantages of lower COP[27].

El-sadek H Nour El-deen et al. have performed a case study of solar powered adsorption cooling system in A1-Minya city climatic condition and found that with increasing ambient temperature is in phase with cooling effect and thus increasing the coefficient of performance or cooling effect[28]. Andrea Boero et al. have performed the simulation and modeling of a solar power absorption cooling

system at small-scale and resulted that proposed system could overcome completely the cooling load of a typical single story building[29].

Ali Alahmer describe in a chapter of solar thermal driven system is most promised technology for small or middle range of cooling capacity.[30].

IV. STANDALONE PV SYSTEM:

The solar PV system used widely in the whole world, is a technology using for the generation of electrical energy by conversion of solar radiation to the direct current (DC). With the help of technology of photovoltaic effect. And standalone PV system is a type of PV system which is used for reducing load directly, particularly in small or medium interprise. Standalone PV system does not transmit the energy over a large distance.[31]. Solar photovoltaic modules, charge controller, the battery and an inverter are the integrated parts of standalone solar PV system. Electricity is generated by photovoltaic modules, and charge controller regulates it from PV generator to the battery with prevention of overcharging and discharging of battery. The battery is used for storing the electrical energy for further use in the absence of solar radiation and by inverter the DC current stored in the battery is converted into AC for bearing loads[32]

Fig.4: Configuration of Standalone PV System[32]

Asmaou et al. investigated the effect of standalone photovoltaic system for electrifying a village of Carmeoon and founded that the proposed system saves the cost with emission reduction because the village was currently relyed on diesel generator[33]. V. Arangarajam et al. have studied and analysed the optimum design of residential standalone solar PV microgrid and proved that optimum size of microgrid power system (4.385 kw) and storage battery (480 Ah/48V) fulfills the daily needs of energy in residential load[34]. Vigneswaran et al. reviewed the cost evaluation of residential standalone photovoltaic power system in the region of Malaysia and concluded that over the span of 25 years with the maintenance value of battery , charge controller and inverter were still more than supplying electricity to the residential house in Malaysia[35]. Akash kumarshukla et al. investigated the detailed design simulation and economic evaluation of standalone PV system in India and found that by designing properly two roof top solar PV system being self sufficient is possible. And also resulted that initial cost of installation of the standalone PV system is high[31]. Nallpaneni Manoj Kumar et al. predict the performance of roof mounted photovoltaic system with different PV modules and showed that the thin film PV module performed well at different[32].

V. GRID CONNECTED PV SYSTEM:

Grid connected PV system is basically electrical energy producing system with the help of PV system but connected with the utility grid for the supply of energy in absence of energy production by PV system. The components of grid connected PV system is same as PV system besides absence of battery and including bi-directional meter which is connected to utility grid in order to measure the unit of electricity exported and imported[36].

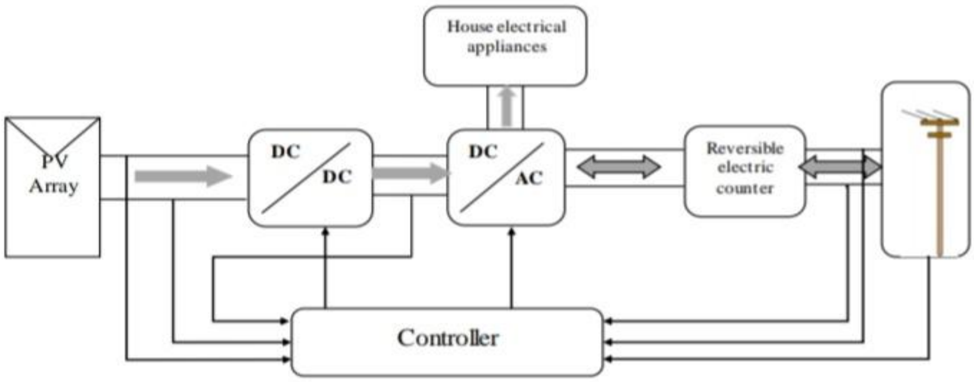

fig.5: Block diagram of grid connected PV system[36]

H. Mammeur et al. investigated the grid connected PV system in family farms of Algeria and sized it for improving the energy balance{37]. Yuan-Truong Nguyen et al. investigated the performance of grid connected PV system in Hanoi and concentrated on improving energy efficiency and reducing the electrical energy cost[38].

VI. CONCLUSION:

This paper is reviewed for balancing of demand and supply of energy in order to achieve ZEB and reducing harmful impacts on environment. This paper has focused on the solar technologies as thermal system for directly used in providing thermal comforts and PV systems as indirect means of energy in other essential requirements. By reviewing various researches in the field of solar thermal and PV system this review is presented which helps in improving in energy balance. The advantages of SWHS is that it is more efficient than the indirect conversion of heating through electrical power produced by PV system and also economically efficient. With the help of SWCS environmental risk is reduced. PV system makes the building self-sufficient and with the help of grid connected PV system there is a chance to regain the installing money by sending back the extra electrical energy to the utility grid.

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