STUDY OF FEASIBILITY OF SOLAR PANEL AT CHANDIGARH UNIVERSITY GHARUAN, MOHALI

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ABSTRACT

The depletion of fossil fuel resources on a worldwide basis has necessitated an urgent search for alternative energy sources to meet up the present day demand. The world also faces the dual challenges of fossil fuel depletion and carbon dioxide (CO2) emissions, and the main candidates for facing these challenges are coal with carbon sequestration (CCS), nuclear and renewable sources of energy. However, safe and economic concepts for CCS have not been proven, nuclear suffers from high cost, radioactive waste management, fuel availability, and nuclear weapon proliferation issues; and renewable, other than hydropower, have been limited by resource limits, high cost, and intermittency problems. Biomass could be a fuel or a source of electricity, but there is not enough land or water to meet the demand and to feed the world's growing population. Wind is intermittent, and the total wind energy resource is limited to a few terawatts (TW) worldwide. Solar energy has huge potential – tens or hundreds of TWs are practical, but it suffers from intermittency. However, recent drastic cost reductions in the production of photo voltaic (PV) pave the way for enabling solar technologies to become cost competitive with fossil fuel energy generation. Scaling of concentrating solar power (CSP) may also enable drastic cost reductions. The objective of this paper is to estimate the potential of solar photovoltaic power at Chandigarh University (C.U.) and finally develop a system based on the potential estimations for a chosen roof area of 1050.1416 m^2. Equipment specifications are provided based on the availability of the components in India. In the last, cost estimation of SPV plant and grid is also calculated to show whether it is economically viable or not.

Keywords: *Coal with carbon sequestration , proliferation, terawatts, photo voltaic, concentrating solar power, intermittency.*

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I. INTRODUCTION

A PV module produces dc power. To operate electrical appliances used in household, inverters are used to convert dc power into 220 V, 50Hz, ac power. Components other than PV module are collectively known as balance of system (BOS) which includes storage batteries, an electronic charge controller and an inverter as shown in the block diagram figure 1 [3]. Storage batteries with charge regulators are provided for backup Power supply during periods of cloudy days and during nights. Batteries are charged during the day and supply power to the load. The capacity of a battery is expressed in ampere-hour (Ah) and each cell of the lead acid type battery is of 2 volts. Batteries are installed with a microprocessor based charge regulator to monitor the voltage and temperature and to regulate the input and output currents to obviate overcharging and excessive discharge, respectively. An inverter is provided for converting dc power from battery or PV array to ac power. It needs to have an automatic switch-off in case the output from array is too low or too high. The inverter is also protected against overloading and short circuits. The overall system performance is usually represented by efficiency, which is defined as the ratio of electrical output to the load (in Kwhr) to the sunlight energy input (in Kwhr) over the surface of panel in the given period.

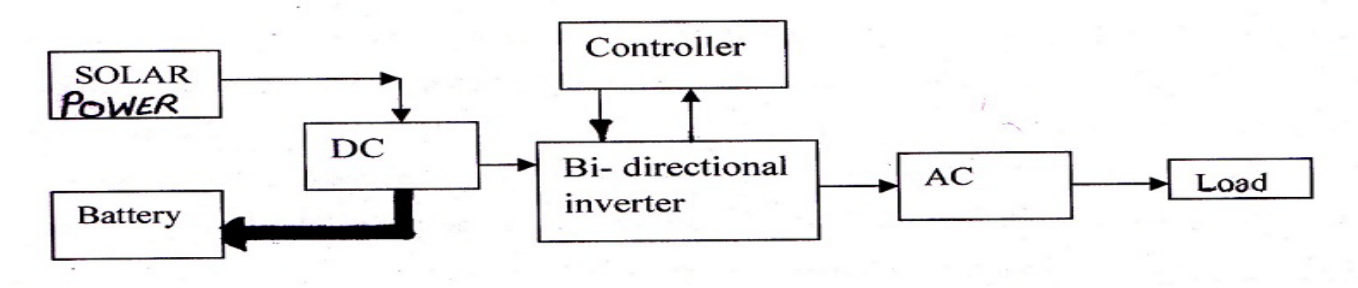

Fig. 1 Block Diagram of an SPS

II. RELATED WORK

Belhad-Yahya,C [1] explained that the performance monitoring of solar photovoltaic (PV) power systems is very essential for initial system evaluation, and continuous output optimization. Currently, PV system monitoring is complicated and expensive and limited to large scale grid connected solar PV plants. They surveyed PV system monitoring methods and proposed a simple and economic method that can be used by stand alone PV power systems. The method uses reference cells to collect real time data and an electronic subsystem for processing. Experimental results show that reference cells power output correlate well with monitored module output and can be used for monitoring and optimization.

Guo Heng, Xu Zheng , Li You-Chun and Wang Hui [2] proposed a novel hybrid maximum power point tracking (MPPT) control strategy for stand-alone solar pumping systems without backup batteries. The whole control process consists of two steps: the judgment of speed up or down and the selection of step size of speed command. Basically, the system with the proposed MPPT strategy is controlled by a normal constant voltage method, while the reference voltage is periodically updated by a new multi-criterion method. In order to compare the control characteristics of different methods, two identical solar pumping systems are implemented. Experimental results show that the proposed control strategy is much better for stand-alone solar pumping systems.

Abou-Hussein, M.S. El-Geldawy, F.A. , H.H.[3] explored the effect of the load profile on the sizing process of the solar cells array (SCA), and as a function of time. It is possible to quantify and determine the load classes that accomplish this. They proposed a novel technique in which an accurate optimum design of the solar cell array (SCA) can be attained. It depends on an hour-by-hour approach with different daily load profiles. Previous SCA sizings have not used this approach. In order to address this problem, it is necessary to use the hourly variation of the load demand and the daily insolation curve of all the months for a specific site. The load demand is classified as industrial, residential, hospital, commercial and miscellaneous. All of these are assumed to have distinct load profiles. Thus, a new approach has been proposed to solve the problem hour-by-hour taking the most common load profiles for the investigation. A generalized mathematical model has been developed for the SCA size as a function of time, month, the SCA tilt angle and load profile.

Bialasiewicz, J.T [4] explained that a substantial increase of photovoltaic (PV) power generators installations has taken place in recent years, due to the increasing efficiency of solar cells as well as the improvements of manufacturing technology of solar panels. These generators are both grid-connected and stand-alone applications. They presented an overview of the essential research results. They explained the modeling of stand-alone power systems with PV power generators. Systems with PV array-inverter assemblies, operating in the slave-and-master modes, are discussed, and the simulation results obtained using a renewable energy power system modular simulator are presented. These results demonstrate that simulation is an essential step in the system development process and that PV power generators constitute a valuable energy source. It is demonstrated that when PV array- inverters are operating in the master mode in stand-alone applications, they well perform the task of controlling the voltage and frequency of the power system. The mechanism of switching the master function between the diesel generator and the PV array-

inverter assembly in a stand-alone power system is also proposed and analyzed. Finally, some experimental results on a practical system are compared to the simulation results and confirmed the usefulness of the proposed approach to the development of renewable energy systems with PV power generators.

Zakaria, Z. A Bai-Chao Chen, Hassan, M.O. [5] explained the methods of design for the appropriate selection of a stand-alone photovoltaic power system for residential application in the absence of utility power supply. For a prescribed power demand design includes the determination of required number of photovoltaic (PV) panels and the proper total size of batteries to store part of the day collected energy for night or to supply power during cloudy times (autonomy) when the collected solar power is inadequate to meet the power demand. Generally the average solar insolation value over 30 years in the particular site is used for the design of such PV systems. Simple calculations are normally conducted to determine the proper number of the solar panels needed to meet the total energy demand during day and night as average kWh per day. The required number of panels depends on the average energy available from the sun at the selected site. With some statistical analysis it is possible to calculate the optimum size of battery storage capacity and total number of batteries required of any particular type.

Meenakshi, S Rajambal, K. , Chellamuthu, C. , Elangovan, S.[6] explained the modeling and power flow analysis of a stand-alone hybrid generating system (SAHGS) comprising of wind and photovoltaic systems. The wind driven self-excited induction generator (SEIG), photovoltaic array and other network components are modeled and simulated using Matlab/Simulink. The variable voltage and frequency of a generator is first rectified and controlled by a DC/DC converter before being fed to a common DC bus. The variable output voltage of the photovoltaic module is also controlled by a DC/DC converter. The DC bus collects the total power from the wind and photovoltaic systems and used it partly to supply the required load demand and partly to charge the battery bank. The individual systems are simulated for varying wind velocities and solar intensities respectively and the results are used to identify the operating modes. A neuro controller is designed to adjust the duty ratios of the choppers and the firing angle of the converter at which the maximum power generation occurs.

Anantha, A [7] explained that Solar photovoltaic based power and energy systems are gaining recognition due to the availability and high solar insolation in most parts of India and the inherent advantage of direct conversion to power unlike a solar thermal system. Solar photovoltaic technology, its application in remote areas, its advantage as a stand alone

system, environmentally friendly and inexhaustible source are some of the positive features of this wonderful source of nature. However, the limitations of day and night cycles and high costs in comparison to other sources of energy hinder its ready acceptance. More and more research is called for in the area of solar photovoltaics along with the discovery of alternative materials with higher efficiency of conversion, reduced panel areas per kW and effective, economic and durable storage systems for sustained production of power. This source alone, if costs can be reduced substantially, can meet the entire requirement of the country. Solar photovoltaics can also be utilised for bulk power for grid interconnected applications. It has a good scope for utilisation on the hybrid system, for pumping of drinking water and remote area power systems.

Mohammad, S. Noor [8] proposed an approximate formula for electron–hole generation rate. In order to determine the applicability of this approximation attempts have been made to calculate short-circuit current, open- circuit voltage, and solar cell efficien cy of an n^+p silicon solar cell. The calculations involve consideration of non uniform doping, spatial dependence of the band, and drift field for the n^+ region, and band gap narrowing, Shockley–Read–Hall recombination, and Auger recombination for both n^+ and p regions. The variations of short-circuit current, open- circuit voltage, and solar cell efficiency with doping concentration of the substrate p region are found to be in good agreement with results obtained from experiments. The trend of the results indicates that proper optimization of the width and impurity concentration of the diffused n region, of the width and impurity concentration of the substrate p region, and of the front surface recombination velocity is necessary for achieving the highest efficiency of a solar cell.

III. PROBLEM FORMULATION

Indian power system is always overburdened due to gap between the supply and demand and therefore power in the secondary distribution system is not always available. Energy is an important input for economic development. Energy is needed for economic growth, for improving the quality of life and for increasing opportunities for development. Since exhaustible energy sources in the country are limited, there is an urgent need to focus an attention on the development of renewable energy sources and use of energy efficient technologies. In spite of non reliable system there is hardly a limited demand of solar photovoltaic systems in the commercial sector of a developing country like India. The main reason for this being lack of knowledge and unavailability of economically attractive or affordable solar PV system. Another reason is that a grid connected solar photovoltaic system

will not be able to supply power for the period when there is no power in the secondary distribution grid. This will make solar PV plant less efficient and underutilized, more over it also requires a sophisticated and costly inverter to operate with the fluctuating voltage and frequency of the grid. Whereas in standalone mode the solar PV power plant requires storage batteries for security of supply. This project focuses on the combination of solar and energy storing systems for sustainable power generation. The calculations regarding the standalone power generation system with storage bank at Chandigarh University, Gharuan, Mohali will be proposed here. In the proposed system there is enough energy from the sun, the load demands can be supplied from the PV-array system. Whenever there is excess supply from the renewable energy, the energy storage bank stores energy which will be used at times when there are insufficient supplies from the renewable energy.

A. Objectives of the present work

- The objective of this work is to examine the technical feasibility and economical viability of Solar Photovoltaic System together with battery backup system.
- To provide an overview of the Chandigarh University Infrastructure, so we can determine whether the solar technology could be beneficial.
- Provide a cost estimate for using solar PV system to support the rebuilding of CU. Infrastructure with solar panels

B. Methodology

Step I – Firstly the required essential load pattern needed for the work will be calculated.

Step II – Total Energy and power required for the day time load will be calculated.

Step III – Total Energy and power required for the night time load will be calculated.

Step IV – Then from the Energy Balance Considerations; calculate total required energy for the solar panel so as to select the proper size of the solar cell panels and storage batteries.

Step V – The required BOS (Balance of system) cost will be calculated.

IV. PRESENT WORK

Site Information : Proposal site for the solar plant is Chandigarh University (C.U.), Gharuan, Mohali, Punjab. Its co-ordinates are :-- Latitude 30º46’5’’ N and Longitude 75º34’36’’ E. The essential electrical energy needs of the Chandigarh University, Gharuan for which we have to design PEPS (Photovoltaic Electric Power System) is given below. The load is calculated for Boy’s Hostel-2 as given below:

Type of load	Quantity	Wattage	Total Wattage	Hours of Operation	Total KWHR
Light points	700	60	35580	17	714
Fan points	600	80	38640	7	336
				Total	1050

We consider only the essential load of Boy's Hostel-2 for calculation for summer season. The consideration of day time load is from 8 am to 4:30 pm whereas the consideration of night load is from 5 pm to 7 am. For designing a PEPS for above loads, first of all we develop a method to analyze daily electrical energy needs and load pattern of the Boy's Hostel-2 at C.U. Gharuan. The total size of solar cell panels and storage batteries are determined from the energy balance considerations **[9 – 15].** The approximate cost of the project is about **Rs 28479430.83** as calculated below.

Sr.No.	Component	Price per Unit (Rs)	Quantity	Cost (Rs)
1.	Solar panel	37.667	647	3653699
2.	Storage battery(lead acid)	1982.54	4441	8804460.14
3.	Charge controller	1899	404	835560
4.	Inverter	10439140	1	10439140
5.	Wiring ,junction box etc			4746571.828
6.	**Total BOS (Balance of system) cost**			**Rs 28479430.83**

If we purchase the energy from the utility, we have to pay Rs 7350 /day as calculated below.

= Total demand in Kilo watt hour x Price of one unit

= 1050 Kwhr x Rs7 / unit

= Rs 7350 /day

Total cost per year is D = Rs 7350 x 365days

D = Rs 2682750 / year

A. Pay Back Period

It is the length of time required to recover the cost of an investment. The payback period of a given investment or project is an important determinant of whether to undertake the position or project, as longer payback periods are typically not desirable for investment positions.

Payback Period = Cost of Project / Annual Cash Inflows

The payback period can be calculated using the following equation.

$$C - ND = 0$$

or $$N = C / D$$

Where C = Rs 28479430.83

D = Rs2682750 / year

Therefore, N = Rs 28479430.83 / Rs 2682750

N= 1.06139254 approximately 1 year.

Therefore the cost of the project installation will be paid back or recovered in 1year. It means the installation of solar panel at C.U. is economically beneficial and helps in effective utilization of electrical power.

V. RESULTS AND DISCUSSIONS

From the design methodology, Roof top approach is provided for the installation of the solar panels at Boy's Hostel-2 C.U. This approach is the integration of the panels to the roof of the building. This approach is provided as it replaces the conventional roof while allowing the natural sunlight to filter through. As a roof, it serves as structural and weather condition requirements by providing structural strength and stability; it protects against the damaged like chemical and mechanical damage; preventing against fires; protecting against rain, sun, wind and moisture; it allows heat absorption and heat storage; controls the diffusion of light etc. in addition to these features it serves as an electricity generator through meeting part of the electrical load requirements of the building.

Because of the highly modular nature of both solar cells and storage cells, specified loads can be powered separately by individual roof – top PEPS for meeting the same energy needs of the different loads as mentioned above. It is expected that with present acceleration in the efforts on the part of manufacturers, designers, planners and utilities with adequate Governmental Support, PV systems will occupy a place of pride in the country's power sector within the next two decades , ensuring optimum utilization of the energy directly from the sun around the year. It is clear that the SPV system can provide some relief towards future energy demands. This PV system consists of PV array with energy storing devices and power electronic devices has been discussed in this project work to achieve an efficient and cost competitive system configuration so that solar power sources could improve the life of people especially in rural areas where electricity from main grid has not reached yet. The methodology adopted seems satisfactory for determining the possible required energy from the solar panel for an arbitrarily chosen area. The total BOS cost calculated seems satisfactory for the proposed design. The surplus energy generated can be used for other useful purposes when sun is not available.

VI. FUTURE WORK

In the future we will calculate the number of PV arrays and cost of the system which can meet the load demand of all campus. In the starting we have not taken into account the air-

conditioners load. In future we will include the load of air- conditioners. A detailed cost analysis can be conducted considering carbon credit to show whether it is economically viable or not. Since the performance of PV system is strongly dependent on loss factors such as shading, PCS losses, mismatch, PV array temperature rise etc. There is a necessity for reviewing these loss factors to evaluate and analyze accurately the performance of PV system. This system can be designed with also some another electrical appliances like filter for suppressing the ripples. A detailed performance analysis of the present system can be carried out to show its reliability as a future work. Solar PV is a technology that offers a solution for a number of problems associated with fossil fuels. It is clean decentralized, indigenous and does not need continuous import of a resource. On top of that, India has among the highest solar irradiance in the world which makes solar PV all the more attractive for India. The state of Orrisa and Andhra Pradesh also houses some of the best quality reserves of silica. India has a large number of cells and modules manufacturers. In spite of all above advantages Indian Photo Voltaic Programme is still in the infancy stage. One of the reasons could be absence of simple, action oriented and aggressive PV policy of the country both in state and central level. More quickly we do it with the professionals more we protect our future energy security.

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