Installation of Solar Power System used for Street Lights and Schools in Khyber Pakhtunkhwa, Pakistan

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***Abstract*— The constant supply of energy on earth is solar energy which is both directly and indirectly used. A part of sun rays can be changed in to applicable electricity by means of an entrusting technology Solar Photovoltaic (PV). This work emphasizes upon the idea of conforming Solar PV panels and sunlight to depict and operate solar system in different areas in Khyber Pakhtunkhwa. The ultimate goal of the solar system will be to enlighten the solar LED street lights, energy savers and tube lights in streets and different schools. This type of solar system is very cost effective in a way that it needs little expenditure initially and less care.**

***Keywords*— Solar Panel, LED Lighting System, Pole, Batteries, Charge Controller, Inverters and Cooling Box**

I. INTRODUCTION

Solar energy is the most demanding energy source due to fact that it is the most abundant and most effective energy source on earth. Solar energy is derived from sun, and this energy is not only environment free but also costless. Latest technology allows the harnessing of solar energy through cells known as solar cells or photovoltaic cells. Photovoltaic cells are placed in direct sunlight, when the direct sunlight hits these cells chemical reaction takes place which produce electric currents [1]. These electric currents are later on converted into electricity which are used to power everyday items like street lights, schools and households. In most of the areas street lights in Pakistan receive electrical energy from national grid, so we need to look for another alternative source of electrical power which does not depend on national grid.

For this purpose we use solar energy. LED based lightning system is used which received charge from lead batteries charged by solar panels [2]. Solar system and LED lightning combination enables its interest in governing authorities to lighten street lights and schools in remote areas without setting up any external infrastructure in a meager traditional way. Stand alone solar street lightning solutions are popular and usually built with customized PV panels and design [3]. Solar energy systems are also used in schools for lightning purpose, internet installing equipment and laptop charging. This system includes photovoltaic cell, batteries and other connectivity equipments [4]. Photovoltaic street lighting systems are in three different lamps namely low pressure sodium lamp, high pressure sodium lamp and fluorescent lamp to determine suitable system in rural areas of the country. The three different lamps are mounted in the same unit and wattage in different areas. The analysis of PV lightning systems with fluorescent lamp is suitable system for installation in rural areas [5]. An experiment is conducted using the PV panel to supply electricity in each building in the schools like classrooms, guard house etc. Since we know that energy especially electricity is the basic requirement for the social and economic development of a country. Therefore, the use of electricity is increasing day by day in every field or department of a country e.g., industries and streets lights require continuous and uninterrupted supply of electrical energy [6], [7].

The main aim for installing solar systems was to promote different solar energy projects in terms of photovoltaic systems based on energy policy of the country. These projects are supported by government budget, involves PV systems such as pumping system, street lightning, school lightning, solar home system (SHM) and board of faculty map [8]. Different energy sources like coal, oil and natural gas are presented in the country in which the author pointed out that these sources are limited in the country and if they are used at the current rate it will finish quickly in the upcoming decades [9]. The stand alone photovoltaic systems sustainability passes through the complement of the systems installed in the field. This stand alone PV system is implanted by the research center in schools of isolated communities and inside solar lightning program [10]. The need of electrical energy is the crucial part of life and increase with each passing day parallel to the developments in technology. But the fact is that cost rises after meeting these needs and damage was done to nature.

So energy is being obtained from clean energy sources such as wind and solar energies [11]. Solar energy gives direct solution for grid to cutoff some loads for stability. One of these loads is street lightning, school lightning especially during summer. This energy provide energy free system where there 2 is less or no power from grid [12]. In this paper, we present installation of solar system and its components for

streets and school lightning in Khyber Pakhtunkhwa, Pakistan. Khyber Pakhtunkhwa is one of the most rich in resources in Pakistan and has the potential of different renewable energy sources such as geothermal, wind, coal and solar energy. Among all of this we consider solar energy as a best option for continuous electricity due to fact of greater radiations of sun in Khyber Pakhtunkhwa. It requires low cost, simple maintenance and initial implementation cost. Rest of the paper is organized as follows: Section II describes the system model of the proposed design. Installation of solar system is presented in Section III. In Section IV, budget analysis is provided. Finally, the conclusion of the paper is given in Section V.

II. SYSTEM MODEL

In this section, we present the basic components used in the installation of our proposed solar system. Description of some of the components like photovoltaic solar panels, batteries, LED lightning, poles, charge controller and inverters etc.

A) Solar Panels

Solar panels are designed to absorb sun rays as a source of energy for generating electricity and heating. It is also called photovoltaic as it converts light energy directly into electrical energy. Solar panel is made up of solar cells. A large number of small solar cells are spreaded over a large surface area which can work together for provision of sufficient power to be used. Larger the amount of light that falls on a cell, larger is the amount of electricity generated. Two forms of solar panels are used to achieve electricity. The most common is the solar electricity cells. Different design of solar panels which are increasing in popularity are the solar water heating panels which can provide all part of homes hot water supply, heat swimming pools and for other purposes. Using solar electricity panels some form of battery storage is attached to the system.

This allows the storage of electricity produced through the day which is used at night (Fig. 1).

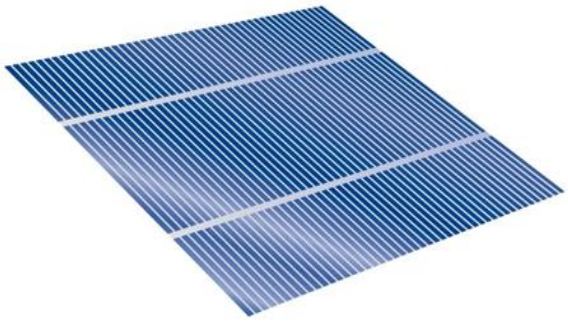

Fig. 1. Solar Panels

B) LED Lights

The solar streets lights are light sources which are powered by photovoltaic panels mounted on lightning structure or integrated itself in the pole. The PV panels charge a rechargeable battery which powers a fluorescent or LED lamp during night. Led lights are usually used for lightning source for modern solar light. These lights provide much higher lumens with lower energy consumption. LED lights give energy consumption up to 50 percent lower than high pressure sodium lamp (HPS) which is widely used as lightning source in traditional street lights. The LEDs lack of warm up time also allows motion detectors for additional gain of efficiency. LED lights are also used in schools for lightning in classroom and examination hall (Fig. 2).

Fig. 2. LED Lights

C) Batteries

Batteries are the most important component in the installation of solar system. Batteries store electricity from solar panels during day time and deliver this energy to the fixture during night. The life cycle of battery is very important to the lifetime of light and capacity of battery will affect the backup days of the lights. Two types of batteries are usually used which are Gel Cell Deep Cycle battery and Lead Acid Battery and many more. During charging time, electrical energy is converted into chemical energy and stored in the form of chemical energy and during discharging time the chemical energy is converted into electrical energy.

The proper selection of batteries for PV systems depends upon the best knowledge of their design features, operational requirements and performance characteristics. Batteries are manufacture by the combination of different sequential and parallel processes. Conduction of charging and discharging cycles on batteries are done necessarily before bringing them to the market for distribution to consumers. Important components of batteries are cells, active element, electrolyte, grid plate, separator, terminal posts, cell events and case (Fig. 3).

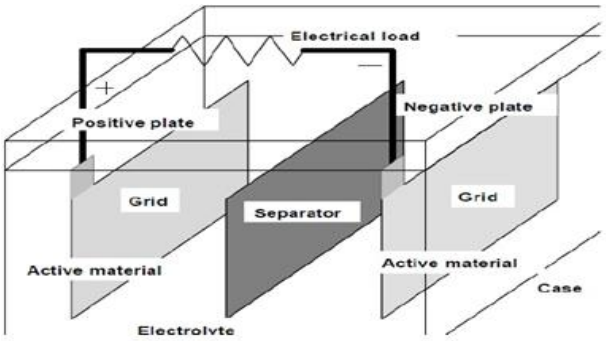

Fig. 3. Batteries

D) Charge controller

A charge controller is an essential part of nearly all power systems that charge batteries. It is also very important for solar street lights and school lightning system. Controllers usually decide to switch on/off charging and lights. The function of charge controller is quite simple, it blocks the reverse current and prevents battery from overcharging. Some charge controllers also prevent battery from over discharge, protect from electrical overload and display battery status and power flow. The PV panels works by pumping electric current to the battery in one direction. At night PV panels pass a little bit current in the reverse direction, causing a slight discharge from battery. The potential loss is minor but it can easily be prevented. Different types of wind turbine and hydro generators also draw reverse current when they are stop. In most charge controllers current passes through semiconductor, which acts like a valve to control current. This is known as semiconductor because current passes only in one direction. This prevents reverse current without any extra effort or cost (Fig. 4).

Fig. 4. Charge Controller

E) Pole

Each street light contains its own photovoltaic panel, independent from other street lights. Number of panels is installed as a central power source on a separate location which supplies power to number of street lights. Pole Lock is designed for pole mounted solar panel framing system which is a component of Sun Lock family of solar framing products.

Many types of frames are assessable for two small panels i.e., 80 W and 85 W panels. They are also obtainable for one, two, three or more larger panels i.e., for 250 W or more (Fig. 5).

Fig. 5. Pole

F) Inverters

Solar inverter is the important component in solar energy system. It converts DC output power into AC current which is fed into grid and directly influences the reliability and efficiency of solar energy system. Mostly 220v AC and 110v

AC are needed for power supply because direct output from solar system is usually 12v DC, 24v DC or 48v DC. For this purpose there is a need of DC-AC inverter in order to supply power of 220v AC to electronic devices. Inverters are usually rated by the amount of AC power that can supply continuously.

The manufacturers provide 5 second and hour surge figures which is able to give indication of how much power is supplied by the inverters. Large number of inverters is used in power application. They are also referred to as a voltage source inverters (VSI). In grid interconnected PV power system DC output power of photovoltaic array is converted into AC power of the utility power system. Below this condition an inverter convert DC power into AC power is required. In solar panels, core technology is associated with these systems is a power conditioning unit (inverter) which convert solar output electricity attuned with the grid (Fig. 6).

Fig. 6. Inverters

III. INSTALLATION OF SOLAR SYSTEM

In this section whole solar system for street lights and schools are described. We mainly focus on our project constraints, sizing array, battery array, cost of the projects, number of poles used and site of system integration (Fig. 7).

A) Basic Requirement

This project gives cheap and easy power to street lights and schools to different areas of Khyber Pakhtunkhwa. The system requires low fixed cost, easily installed and reliable. The project gives great idea to install street lights in such areas where there is no light or less power.

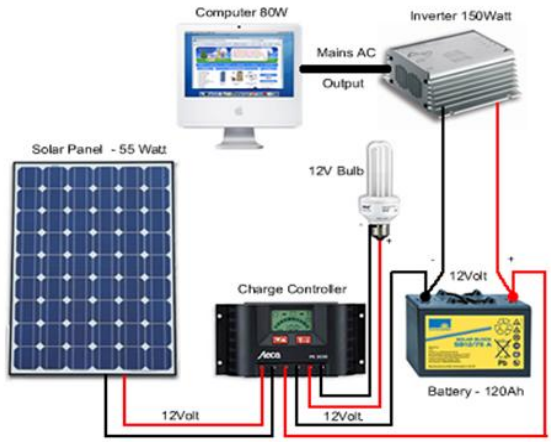

Fig. 7. Block Diagram

B) Collecting Data

In this section we focus on total load for street lightning and number of schools in different areas of Khyber Pakhtunkhwa. This work presents an independent street lightning system positioned on solar energy as a primary source and batteries as a secondary source, lighting emitting diodes (LEDs) as a lighting source. This system is also proposed for remote areas like roads and cross roads. Furthermore, it is highly efficient because all power stages are implemented in DC current. The architecture of LEDs fixture, in order to compensate a 70 W high pressure sodium (HPS) lamp, is performed. The solar system for streets lights and schools improve the life style of peoples, prevents robberies and literacy in these areas. We visited different areas of Khyber Pakhtunkhwa and collecting data regarding total number of solar street lights poles and number of schools. We finally summarized and calculated the combine data of solar street lights pole and number of schools in which solar system is installed.

Energy Calculations: In this section we shall calculate generalized form of energy.

Total number of solar street poles = 25

One LED frame load = 12watt

One solar street pole wattage = 12watt

Total number of pole wattage = 25 *12 = 300watt

Daily solar LED energy units used at night 300*10 = 3kwhr

Where 10 is the total number of hours in which solar LED is used.

Similarly if we calculate load for 1 week.

Solar LED energy units used in 1 week 300 * 70 = 21khwr

In the same way we can calculate the total load of school by knowing the total number of lights and fan used in school.

C) Balance of System Design

It illustrates the basic design of our system which includes mounting of solar street panels, wiring in system and system equipment.

Solar panels array: The wiring of solar system is made in such a way that solar system is separated from each street light to provide power to huddle of street lights.

- The PV array gives us the ability to sculpt unlimited solar panels individually or in groups to connect them in series or parallel combination to form solar array.
- Poles directly mounted into the ground or fixed in concrete.
- Ground work mounts, such as concrete slabs or poured footings.
- Ballasted foot mounts i.e., concrete or steel based that use weight to sheltered solar module system in position do not required ground penetration.
- Pole mounts which are directly attached to the roof structure used additional rails for attaching frames or module racking.

Wiring: Wiring of the system can be made by the position of the components. The panels are placed parallel to the ground and the wiring is done in such a way that could be simple and easy to understand. The infrastructure like poles and wiring are not replaced to lodge because the system has no similar constraint as standalone system. The end result is that the system can be intended as big as required with the sufficient batteries and solar panels to supply enough power to the LED lights. The batteries of the system are kept in a cabinet where it is insulated to give maximum power protection against heat. A monitoring device is equipped with the system which alerts the authorities of any tampering or removal of equipment from the system. Due to this device the threat of theft will not eliminate but reduce time to caught culprits red handed. The wiring and maintenance is done at one point for several lights and combined with the monitoring system. The maintenance is done on system from the central computer.

IV. BUDGET ANALYSIS

In this section, we discussed the final execution of our project which includes civil work combination, possession of solar components and the total cost of the project. In start large expenditure is needed for LED and PV solution, however excavating work for power wires and energy expenses are not useful. The extravagant sustainment work can be lessen with the help of long LED lifetime causing profit by LED over usual lighting. Several stages of our

system installation occur. All the members of our team work hard. We predict after purchasing LED lights, street light pole, batteries, wiring, charge controller and system tools to be purchased to the areas of Khyber Pakhtunkhwa. While completing our system components we shall calculate our skilled workers per person labor charges. After all this, we shall implement our solar street lights system. All these system components are shifted to the site by road transportation. Total cost is also shown in Table 1.

Table 1: Estimated total cost

S. No	Name	Description	Rs.
1	LED Solar power street Light KB7100	12W	60000/-
2	solar street light battery	12v 100ah	20000/-
3	10A solar charge controller	12V/24V auto	28000/-
4	Solar power inverters	5kw 12v 220v	30000/-
5	Solar street light pole	4m 12/watt	35000/-
6	Electric high temperature shield wire	5mm	10000/-
7	LED poles installation	25 poles	55000/-
8	Skilled workers	15 men	60000/-
9	Final installation	-	85000/-
10	Transportation	-	25000/-
11	Total	-	408,000/ 3923 USD

V. CONCLUSION

In this paper, we install solar system and its components for street lights and schools for different areas of Khyber Pakhtunkhwa. The system we provide gives electricity to street lights and schools to prevent accident, robberies and safety at night remove educational literacy and improve human life style. We also presented the complete analysis of our project regarding initial cost, including LED lights, street light poles, batteries, inverter, its installation and transportation cost. Such solar system project requires low initial cost, less maintenance and more economical.

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