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Design Orientation and Installation of The Stand-Alone Solar PV System

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Abstract- Filling the energy for the world is directed to the renewable energy due to the shortage of natural fuel and oil. Among the renewable energy, energy from sun, solar energy is the natural largest source for the world in this universe. Facilitating the classroom in remote area to promote the education status, a 3kW stand- alone photovoltaic (PV) power system had been constructed. Conversion efficiency 14%, 16×160 W solar modules were used to supply ten computers, one overhead projector and IP star internet equipment. The array was mounted on the roof-top of the class-room. This configuration allowed the array to be oriented at true south while resisting the high wind hazard associated with a roof mount. In this paper, experience gained in choosing orientation and installation of the stand-alone PV system is share.

Indexed Terms- installation, orientation, stand-alone, solar PV system

I. INTRODUCTION

The solar modules should be mounted in a location where they will receive maximum sunlight throughout the year. The location must not be darkened. This is probably the most important requirement for a location for solar installations because it has been shown by frequent observation that the highest losses occur through partial darkening of modules. Even the darkening of part of the installation leads to power losses of the whole installation [6]. In the Northern Hemisphere, the modules should face south, and in the Southern Hemisphere, the modules should face north. Modules facing 30 degrees away from true South (or North) will lose approximately 10 to 15 per cent of their power output. If the module faces 60 degrees away from true South (or North), the power loss will be 20 to 30 per cent. When choosing a site, avoid trees, buildings or obstructions which could cast shadows on the solar modules especially during the winter months when the arc of the sun is lowest over the horizon [6].

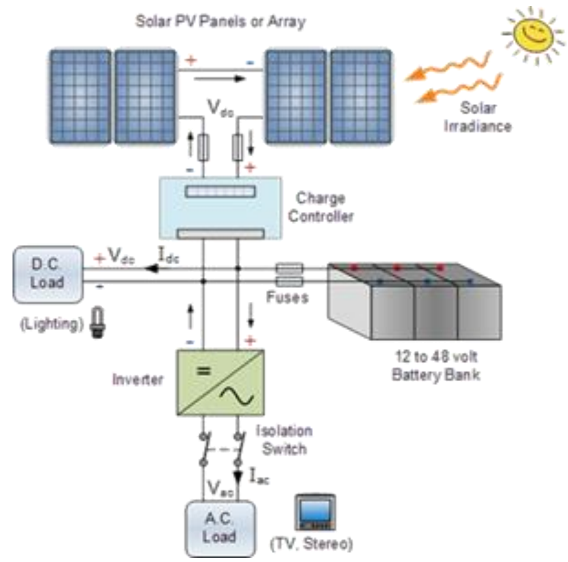

Figure1. Components of Stand –Alone PV System

In this paper, the PV array is mounted on the roof top of the classroom where the shade free, it is so important to gain maximum power output of the PV system.

II. PHOTOVOLTAICS SYSTEM COMPONENTS AND INSTALLATION

The major component of a stand-alone PV system is the solar arrays, and the other several parts are charge controller, inverter, and batteries as in Fig 1.

A. Solar Panel

Conversion efficiency 14%, 16×160W solar modules are connected as four pair, 4×160W panels connected in parallel as one pair or a set due to the charge controller which is 20 A, that are chose. Four sets of solar arrays feed into the charge controller each, which then regulates the battery charging.

Figure 2. Conversion Efficiency 14%, 16 × 160 W Modules Mounted at the Roof-top of the Class Room

Fig.3 Wire Connection in Connection Box and Fuse Box

This system uses a ground mount design and built an aluminium rack on the classroom roof. These arrays are oriented at true south and tilted 37°to get maximize solar energy in winter. The modules are virtually checked for any cracked glazing, and check the frame, wiring box and the back's plotting material are intact. And then the open circuit voltage and current of each panel is checked before carry them onto the roof and assemble a group of modules into a sub-array on the ground, these are connected with proper wiring to form sub-array which are checked open circuit voltage and current before being moved to the roof as a unit.

Fig. 2 Conversion efficiency 14%, 16 × 160W modules were mounted at the roof-top of the class room After all checking is finish, the arrays are attached to the mounting rack on the roof and then connector boxes and fuse boxes are installed and wiring the connection.

B. Charge controller

A charge controller is an important part of the system which is connected between the arrays and the batteries. Its function is to regulate the power flowing from a photo voltaic panel into rechargeable battery. In this project, four 20A charge controllers are used. Each charge controller is connected one set of arrays (four panels that connected in parallel). The charge controller used in this project designed is based on the principle of maximum power point tracking (MPPT).

Fig.4. Charging Voltage and Current of Each Controller

The solar panels are connected to the charge controller's PV terminal with right polarity; connect the battery to the controller's battery terminals with right polarity of battery or PV. Put the solar panel in the sun, and watch the battery charge up. When the battery is low and the sun is shining, the LED will be red. As the battery reaches the float voltage, the LED will alternate red/green. When the sun goes down, the LED will shut off.

C. Inverter

Inverter is the device that changes DC to AC. PV modules and arrays, and batteries produce direct current DC. Electric loads that are connected to the stand-alone PV system are designed to operate an AC. It is connected between panels array or batteries and AC appliance or load and place near the batteries and away from the appliance. There are two basic types of inverters to consider; one is produce modified sine wave and other inverter is produce true sine wave. In spite of being poor quality of modified sine wave inverter, it is less expensive and can't produce quality wave form required by some equipment. In this project, we designed pure sine wave inverter which produced a true sine wave is produced.

D. Battery

To storage the electricity from the PV system that without using directly are store in batteries for using any time or later. The lead acid deep cycle batteries are choosing to use and which nominal capacity and voltage is 200AH and 12V respectively. The nominal voltage of this PV system is 24V, therefore, batteries are connected in series and parallel to gain required voltage and current. Two pairs of four batteries are connected in parallel and then these two pair connected in series to attach the two 20A charge controller for charge the battery.

Fig.5. 200Ah batteries for storing the charges for later use

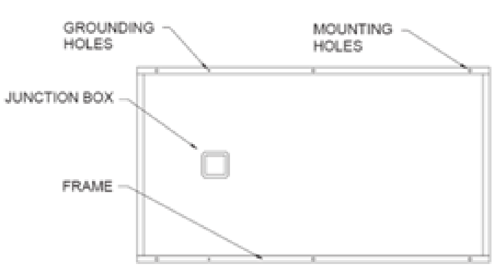

Fig.6. Back Side of Module
Source: [6]

Because of lead acid deep cycle batteries which require ventilation when charging the batteries. So, these all batteries are placed well ventilated room.

E. Wiring

Wiring is the one of the important components of the installation, as suitable wiring ensures efficient energy transfer. The wiring used in wiring between the arrays and controller, batteries, battery to inverter or inverter to appliance are different according to the flow of current. Check the wiring connections are tight before closing the electrical connector or box on each array. Each wire size is carefully select according to the international practices.

F. Fixing of Modules

The frame of each module has mounting holes, can be seen in Fig.6, which are used to secure the modules to the supporting structure as in Fig 7. The four holes close to the corners of the module are most often used for mounting. Clearance between the module frame and the mounting surface may be required to prevent the junction box from touching the surface, and to circulate cooling air around the back of the module.

In case the modules will be mounted on the roof or wall of a building, the standoff method or the rack

Fig. 7. Mounting the Structure Bar

method is recommended. The example of a ground mounted structure is shown in Fig.8.

A. Standoff
The modules are supported parallel to the surface of the building wall or roof. Clearance between the module frames and surface of the wall or roof is required to prevent wiring damage and to allow air to circulate behind the module. The recommended standoff height is 4.5 in.

B. Rack
The supporting frame is used to mount modules at correct tilt angles. The modules are not designed for integral mounting as part of a roof or wall. The mounting design may have an impact on the fire resistance [6].

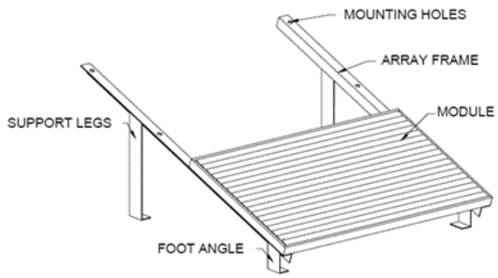

Fig.8. Basic Rack or Standoff Module Mounting Structure
Source: [7]

The modules can be preinstalled by connecting a cable of an appropriate length in the connector box. Pay careful attention to the polarity of the connections. The prepared modules are screwed onto the angles and the cables are then connected into the next module box. Check polarity, cable tension and that the connector box is watertight when closed. According to the size of the installation the modules are connected in several strings in a row. The cable ends of the strings have to be marked appropriately to string and pole so that no mix-ups arise.

G. Grounding
Proper grounding protects photovoltaic power system users from electrical shock. Ground, grounded and grounding are terms describing the deliberate connection of circuit's wiring framework and appliances to a ground rod or grounding electrode which has been driven into the earth.

A ground fault is a failure in an electrical wiring system caused by inadequate grounding. A ground fault occurs when a current-carrying conductor comes into contact with the frame or chassis of an appliance or an electrical box.

Two methods of grounding an electrical installation are equipment grounding and the grounded conductor. Equipment grounding provides protection from shock caused by a ground fault. The grounding wire must be not only connected to every non-current carrying metal part of the installation to ground to ground also bonded every metal electrical box, receptacle, equipment chassis, appliance frame and photovoltaic panel mounting. The grounding wire is never fused, switched or interrupted in any way. It is also a good idea to ground the array mounting frame immediately upon installation.[1]

III. ORIENTATION OF THE PV SYSTEM

A. Module Tilt Angle and Orientation
The orientation of the module with respective to the direction of the sun determines the intensity of the sunlight falling on the module surface. Two main parameters are tilt angle, which is the angle between the plane of the module and the horizontal, and the azimuth angle, which is the angle between the plane of the module and the due south. The optimum array orientation will depend on the latitude of the site, prevailing weather conditions and the loads to be met. For higher latitude, the maximum output is usually obtained for tilt angle of approximately the latitude angle minus 10° to 15°. For lower latitude, the maximum annual output is obtained when the array tilt angle is roughly equal to the latitude angle and the array faces due south in the northern hemisphere and vice versa for the southern hemisphere.

Modules may be mounted at any angle, from horizontal to vertical. Select the appropriate orientation to maximize sunlight exposure. The

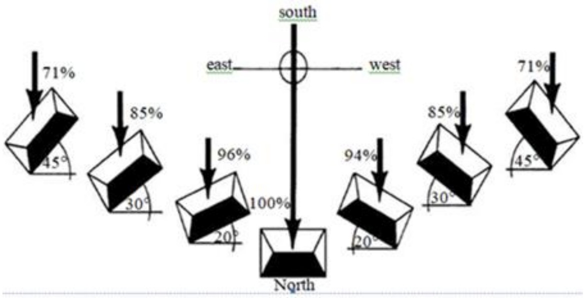

Fig.9. Module Orientation, Tilt Angle and the Percentage of Energy Gain, Source: [7]

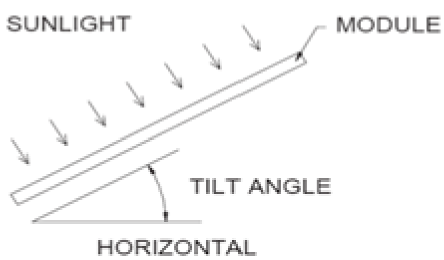

Fig 10. Module Tilt Angle
Source: [6]

module orientation, tilt angle and the percentage of energy gain are shown in Fig.9.

Solar modules produce the most power when they are pointed directly at the sun. For installations where the solar modules are mounted to a permanent structure, the solar modules should be tilted for optimum winter performance. As a rule, if the system power production is adequate in the winter, it will be satisfactory during the rest of the year. The module tilt angle is measured between the solar modules and the ground shown in Fig.10. [6].

The projected area, Mandalay that is the middle part of Myanmar, is situated in the north latitude **21**°58'48" and the east longitude 96°05'24" so solar module are oriented true south and tilted 37° to maximize winter gain.

B. Mounting of Structure Bars

The bars should be orientated towards the south. The distance of the bars from each other depends on the frame construction of the modules and is usually indicated by the supplier. The measurements can also be obtained from the module data sheet. To achieve this, a roofer should be employed. No water must penetrate any protective layers of the roof. The bar angles are fixed onto which the modules are then screwed.

One has to ensure sufficient distance between the modules so that they do not darken each other when the sun is low. The appropriate distance depends on the size of the modules. As a rule of thumb, it is indicated for 30º: structure distance >2.6 module width. But the distance is most often indicated by the structure manufacturer or by the supplier of the module [5]. In this system installation, 37º angles are pushed onto the structure bars and are fixed at an appropriate distance.

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REFERENCES

[1] C. S. Aung, – Sizing the Stand-Alone Photovoltaic System, ‖ in *Proc. 1st Interenal Conf. Science and Engineering (ICSE I)*, Yangon, Myanmar, 2009, pp. 415-419.

[2] C. S. Aung and K. M. Latt, ― Design and Implementation of 3kW Stand-Alone Solar Electrification System, ‖ presented at the CAFEO 27, Singapore, Nov 29-2, 2009.

[3] C. S. Aung – Design and Implementation of 3kW Stand-Alone Solar Electrification System for Classroom in Remote Area, ‖ Ph.D. dissertation, Dept. Engg. Phys., Yangon Technological Univ., Yangon, Myanmar, 2010.

[4] Davis, G., Govemor. 2001. A Guide to Photovoltaics (PV) System Design and Installation. California Energy Commission, June 2001.

[5] Dongying PV Power Co, Ltd, No Date. Installation Instruction Manual for crystalline solar photovoltaic Module China photovoltaic

group, Dongying PV power Co, Ltd. February 2009<http://www.cnpv-power.com>

[6] Pacific Solar Tech, Inc, No Date. Installation Manual for Pacific Solar Tech MicroPV Solar Module. February 2009 <http://www.unirac.com>

[7] Sandia National Laboratories's Photovoltaic Center. No Date. Lesson1. Energy use in the Home Pennsylvania Solar Course. January 2007