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Effects of MPPT and Soiling on PV Modules Efficiency

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***Abstract*-Solar energy is the necessity of the modern world and to handle energy crisis it is one of the best recognized renewable energy sources. Solar energy needs to be tracked to extract maximum possible energy due to the sun moment and for this purpose MPPT is used to track the MPP point with dual axis tracking giving higher efficiencies. This paper presents the analysis of the MPPT using P & O technique and the soiling effect for Peshawar region. Shaukat Khanum Memorial Cancer hospital (SKMCH) is taken as a case study. The study shows that a total of 9% power is lost on monthly basis for 401 KW solar systems. The Proteus simulation of the MPPT with dual axis tracking gives better results as compared to other techniques.**

Keywords: P&O, Renewable energy, Sun moment, Proteus, Tracking

1. INTRODUCTION

Modern world is facing energy crisis and the researchers are working to find out new ways to produce energy. There are different sources including fossil fuels like coal , diesel, Petrol and gas producing energy but these are depleting on a rapid rate so renewable sources are needed which is wind ,hydro, geo thermal and solar etc. Solar is one of the easily available energy extracted by using solar panels but they are facing the problem of lower efficiency up to 16%.To maximize the efficiency of the panels different techniques are commonly used. For an optimized and good design of a system several features are studied including sensitivity range, solar panel size and the tracking time for a single axis tracking system. Such systems can be used in different fields of electronics and mechanical [1].Dual axis tracking is another method for panels output enhancement using latitude for the tracking the sun position having greater efficiency of GPS based system for the start of the step-up process. It has an advantage of less time consuming with easy installation and thus economical giving better results[2].A demonstration tool has been designed using different features of the system like stability and accuracy for extracting maximized output [3].Another optimized system requiring fixed tilt and angle of azimuth using tracker in both the axis giving 28% greater efficiency[4]. An assembly of two dc motors with five photodiodes observing large amount of sunlight giving bulk power is another approach with low error of 5% [5].Combined effect of boost converter is used with single axis tracker using induction motors instead of simple dc motors consuming less power comparatively hence giving greater overall system power output [6].Panels efficiency in conditions like hazy weather incremental conductance method with the use of stepper motors and MPPT contributing large power output[7].A mathematical model has been proposed and is simulated investigating the effect of weather conditions, temperature and size of panels and to make the panel perpendicular to the sun giving available power to extract[8].Panels connection configuration has been discussed that during clear sunny day large power can be extracted using series connection of the panels and parallel for low solar insulations[9].Perturbation can be accurately suppressed using P&O method with the use of buck converter[12].
Soiling is the basically dust falling on the panels and is categorized into to two types which soft and hard reducing the panel output [16].Regression model has been used after cleaning the panels with different cleaning agents giving 7% and 1% loss of soiling for sandy and compact soils respectively for the studied system of one megawatt[17].Soiling for Saudi Arabia is 16% and 2% for April and July respectively from which economic study has been done giving 3$/year expenses for automatic and up to 7$/year for manual cleaning of the panels. Here short circuit is finding out as compare to power [18].A 3D model is suggested for analyzing the heating effect with the soiling on the panels using force draft fan technique. Soiling can be reduced by using this technique which is applicable to small scale power plants [19].

2. DESIGN OF MPPT WITH DUAL AXIS TRACKING USING PROTEUS

Analysis of different techniques shows that P&O technique is one of the easiest and having good stability with no perturbation near the MPP point. Here dual axis tracker is designed with buck boost converter and its combined effect is analysed using Proteus simulation. Dual axis tracker with MPPT schematic is given below.

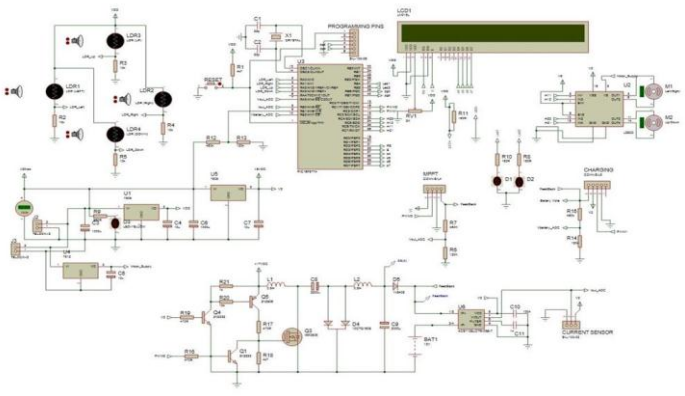

Figure 1 Simulation diagram of the project

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In the above figure four LDR's are used with two dc motors making the panel perpendicular to the sun light and the MPPT electronically maximizing the power output.

3. COMBINED EFFECT ANALYSIS

After designing the dual axis tracker and MPPT in Proteus its simulation is given in the below figure shows working of the dual axis tracker. This figure shows the motor movement when sun rays fall on the right LDR hence moving the panel in the respective direction.

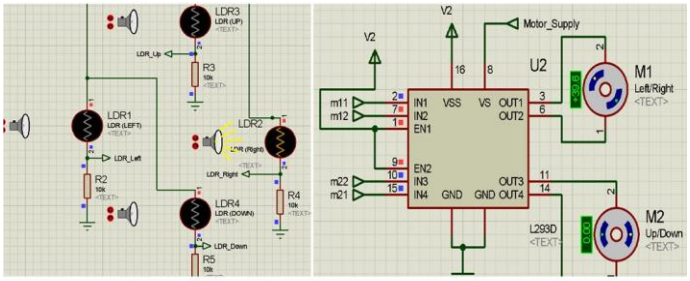

Figure 2 Dual axis trackers showing the working of LDR right

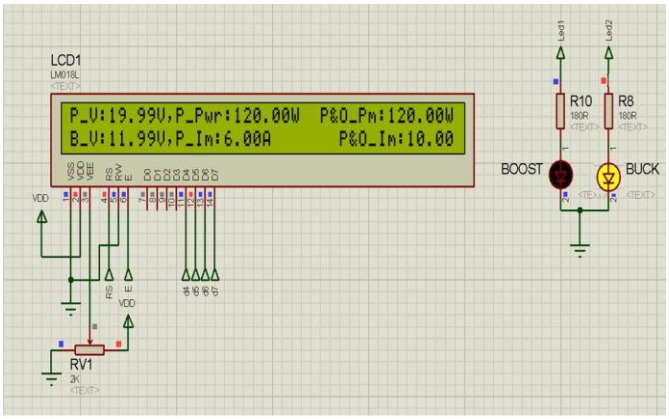

Figure 3 LCD showing the output results after buck operation

Boost operation is shown in the LCD when 120W solar panel giving 20V and 6A is connected to 12V battery. Current is boosted to 10A hence increases the efficiency.

4. RESULTS

In simulation the effect of dual tracking is not counted and for this purpose using literature its effect is counted to 30% and 28% for MPPT giving useful power output of about 94.8% as compared to fixed panel system.

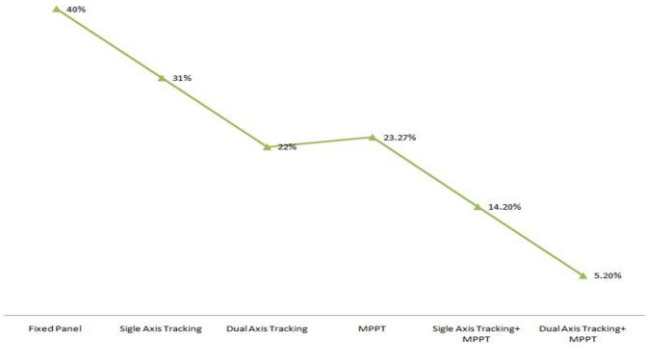

Figure 4 Percentage power loss

The Percentage power loss diagram shows that if we are not using any tracking and MPPT methods then for the specified system total power loss will be 55% which is then reduced to 28.50% with dual axis tracing and MPPT.

5. SOILING EFFECT IN PESHAWAR A CASE STUDY

Efficiency of solar panels can be maximized considering different factors like insulation level, temperature, location of the plant and dust accumulation. For this purpose Shaukat Khanum Memorial Cancer Hospital (SKMCH) is taken as a case study and the effect of soiling for different months is calculated.

5.1. Solar Plant description

Plant is located in Peshawar Pakistan (Lat.34.0ºN, long.71.5ºE) and the figure shows the geographical location of the PV plant. The plant is located on the roof of the hospital building with fixed tilt angle.

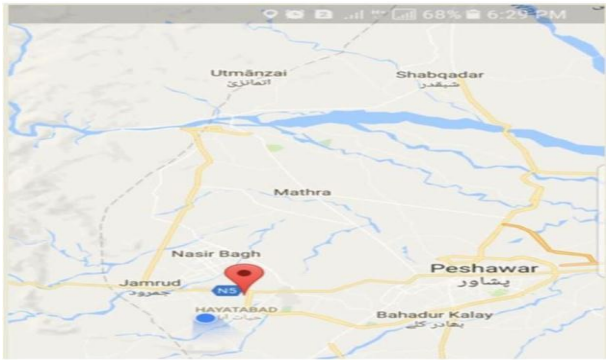

Figure 5 Geographical location of PV plant

Figure 6 Solar panel field showing different blocks

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5.2. Plant architecture and Panels configuration

Block diagram of the PV plant is illustrated below in figure 7. Shaukat Khanum solar plant consist of 1540 panels each of 260W producing total of 401KW. One string contains 22 modules in series producing 840 VOC and a close circuit voltage of 691 volts. Panel name plate is given in the below figure.

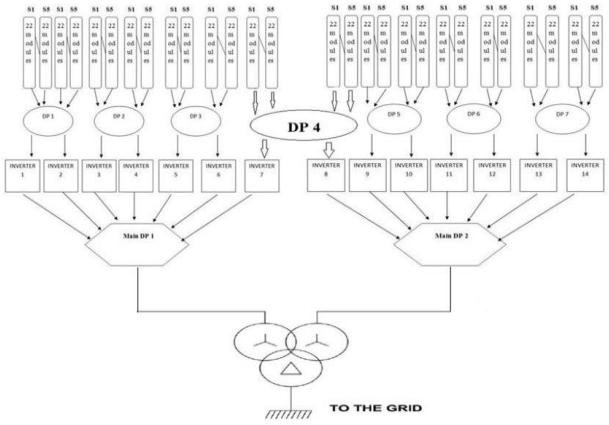

Figure 7 Block scheme for the SKMCH solar plant

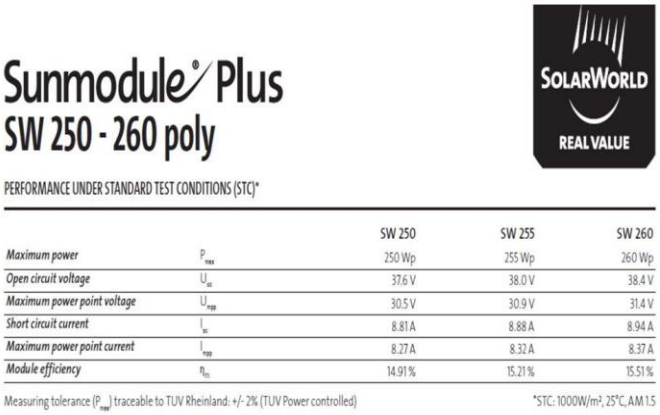

Figure 8 Solar panel name plate readings

There are total 14 inverters supplied by 5 strings of panels which is first passed from the distribution panel having 10 ampere fuses for protection of each string and at last inverters are connected to two main DP's consist of 7 inverters and then they are sinked with WAPDA and the end results are displayed on the cluster controller giving overall production as show in the figure.

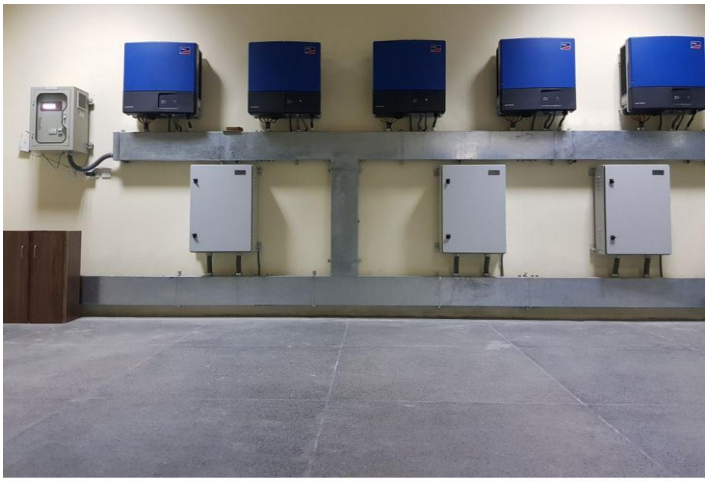

Figure 9 Inverters, distribution panel and cluster controller

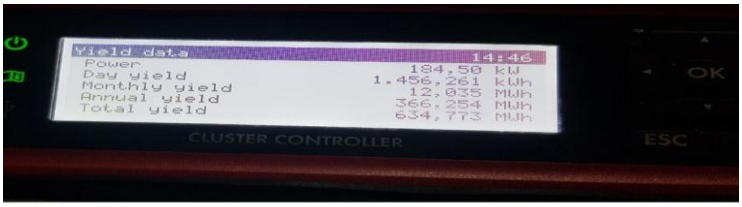

Figure 10 Cluster controller

Figure 11 Main distribution panel

The modules are divided in to six blocks containing different number of panels and two blocks are cleaned manually every day and no cleaning on Sunday only. Block A and B contains 254 and 432 panels respectively.

The soiling effect is calculated before and after cleaning the panel which in this case is blocks A-B. Total power loss due to soiling is thus found out for different months of the year and the overall results obtained is given in the tabulated form.

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S.NO	Month	Experiment Date	Cleaned panels O/P	O/P after Two days	Monthly % Power Loss
1		11/3/2017	960.4 Kwh	955.31 Kwh	8%
	March	26/3/2017	878.08 Kwh	873.58 Kwh	7.7%
2		4/5/2017	1048.21 Kwh	1041.82 Kwh	9.1%
	May	19/5/2017	1015.28 Kwh	1008.88 Kwh	9.5%
3		3/7/2017	982.35 Kwh	975.48 Kwh	10.5%
	July	15/7/2017	839.66 Kwh	833.67 Kwh	10.7%

Table 1 Experimental results of soiling

Blocks A-B produces 960.4Kwh in March at a clear sunny day and 955.31 after soiling of two days which is monthly power loss of 8% similarly different results are obtained for different months of the year giving power loss from 7.7% to 10.7%. The average power loss is about 9% in Peshawar region. On June 21, 2017 when rain was started the system was producing power of 917Kwh and on the next day when sky was clear it produces 2250Kwh.

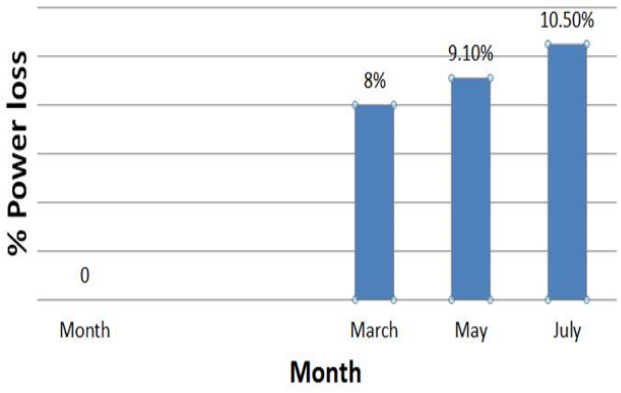

Figure 12 Monthly soiling losses

The system was producing different energy at different months of the year due to changing solar irradiance and the pattern recorded for Peshawar is given in the figure below.

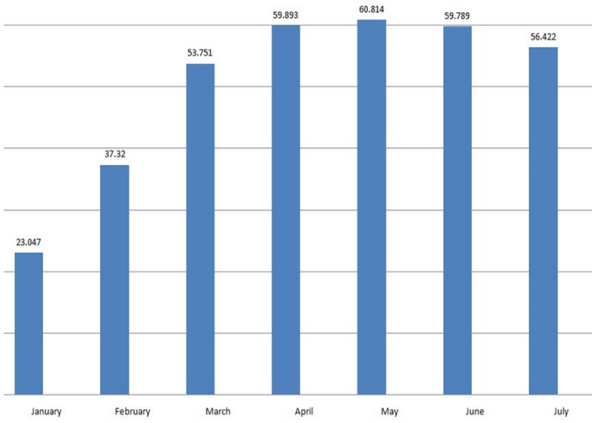

Figure 13 Monthly energy productions

6. CONCLUSION

Sun light is easily available for electricity using PV cells and tracking in both the axis electrically i.e. maintaining the power production at MPP point make possible by P&O method having no oscillation and has a stable system functioning. Both methods are producing large power compare to panels at a fixed position with no moving capability. First time soiling analysis for large solar plants in Peshawar has been taken and the results obtained from the analysis of 401Kw plant shows that total of 9% soiling is present and this may vary for other regions depending on the weather conditions etc. The effect of soiling for the respective plant can be minimized by automatically cleaning the panels at a specific schedule. Different cleaning methods like washing with soda enhance the power production minimizing the effect of dust falling.

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