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Reconfiguration Methods for Solar Photovoltaic array And Economic Evolution of Solar Cell

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Abstract— *There are various methods present to optimize the performance of the solar Photovoltaic cell. One of the method is re-arranging the solar PV modules in various configurations in real time to obtain maximum output for various irradiance level. Performance of a solar photovoltaic (SPV) array is affected by variations in temperature, solar insolation and array configuration. In this paper, mentioned various type of reconfiguration methods for solar photovoltaic array of 4 x 4 and also regarding implementation of thisre-arranging configurations to the solar photovoltaic array. Also discussion regarding the cost of solar panel and about cost per watt history of solar panel . There is discussion regarding the financial assistance provide by government of India for promoting roof top solar power plant in Indiaand also about the Return of Investment (ROI) in solar power plant*

Keywords—*cost effective configuration, irradiance profiling, Photovoltaic System, Reconfiguration System , solar rooftop, prices history of solar panel*

I. INTRODUCTION

The major concern now days is fulfilling the huge power requirement and that too with the limited source of fossil fuel we have. The solution for the fuel can be overcome through green energy fuels like tidal, geothermal, solar, etc...The generation of electricity is made, nowadays, almost exclusively from hydropower, thermal and nuclear power. With the increase in energy demand and concern for the environment, it has become necessary to use alternative and clean sources of the electricity generation. The most widespread alternative energy sources is the photovoltaic systems. PV energy depends particularly on sunlight, and the generation of electricity produces no type of residue, thus a clean way of energy production. In addition, the reduction of transmission and distribution losses and the possibility of reverting the surplus electric power to the power utility increases its use in the domestic and commercial level.

The photovoltaic system's efficiency is moreinfluenced by the atmospheric condition and the irradiation pattern on the solar PV Array. It has been observed that under uneven irradiation pattern the energy production by the solar PV is decreased and also the overall efficiency of the whole system is drastically affected by such uneven irradiation pattern. Due to this different shading pattern are form on the array which results in lower performance ratio of the PV system. Despite these advances, main limitations of PV cell is that efficiency of more than 30% are realistically unattainable with many commercially available solar PV module, it is generally closer to maximum till 20%. There are various methods for overcoming the effect of partial shading on the PV array. Here the Reconfiguration methods for PV array are mentioned. It is found that where PV modules are rearranged in real time, so that the PV system can produce the highest amount of energy. Basically the rearrangement of the individual PV module is done in this scheme for better result. The only complexity is the development of good algorithm and the program as per shading analysis.

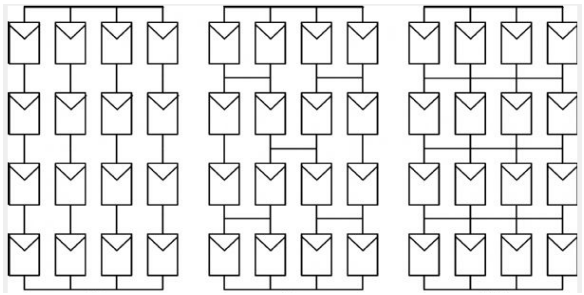
II. SOLAR PV ARRAY TOPOLOGY

There are different ways to interconnect the modules in a PV array, and each type of arrangement has specific applications and features. The general classification is as series-parallel topology, total cross tied topology and bridge link topology.

Series Parallel (SP) Topology: The PV modules are connected in series' first and then the resulting rows are combined in parallel form. In this topology, the power produced by each module is taken into consideration and if the power produced by any module being less than threshold value are bypassed in such a way that does not affect other healthy modules in connection.

Total Cross Tied (TCT): The PV modules are connected in parallel fashion first and then this arrangements are combined in series form. In this topology, the modules producing unequal amount of power are grouped in such way that the rows formed by these modules produce near about equal power.

Bridge Link Topology (BL): The PV modules here are connected in series topology and then these arrangements are connected in parallel. It consist of two parallel string having two series connected modules, there exists tie between the bridges.



SP BL TCT

Fig. 1. Basic topologies configurations.

A. TCT topology reconfiguration system

The method of irradiance equalization is generally used in the TCT topology, in which the shaded modules are equally distributed. In this topology the sum of the irradiance for each row is kept corresponding to one particular value so that the output from each row will be near about the same value.

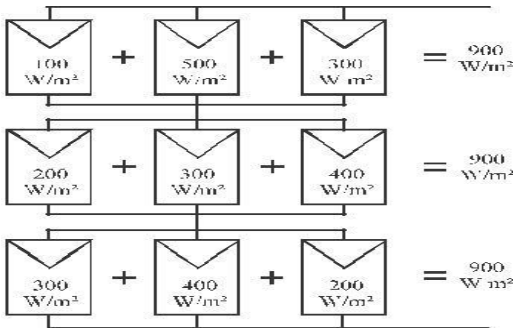


Fig. 2. Irradiance equalization example

Now to equalize the irradiance on each PV modules, there should be formed two part of PV array. One part as the fixed part and another part as the dynamic part. In the fixed part the modules are arranged in small part such that they can be connected in the parallel fashion. When the shading occur in the row of the fixed array, the dynamic part are such that they come in the parallel with the fixed part which helps to compensate. Fig. 3 shows an example of irradiance equalization, where the fixed and dynamic parts of the reconfiguration system can be observed.

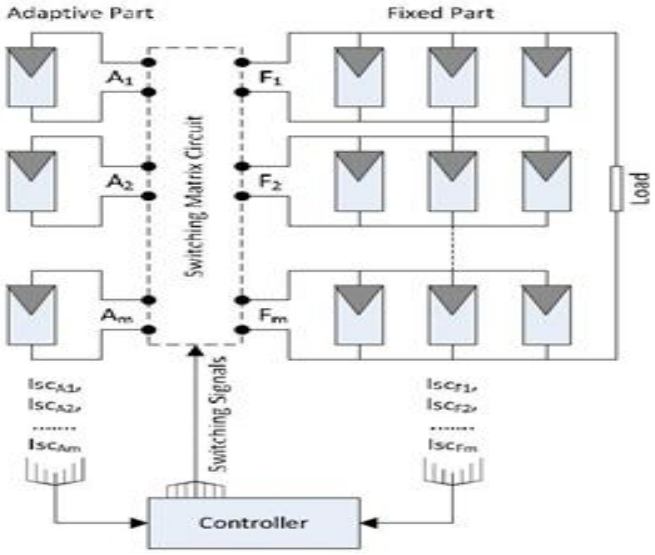
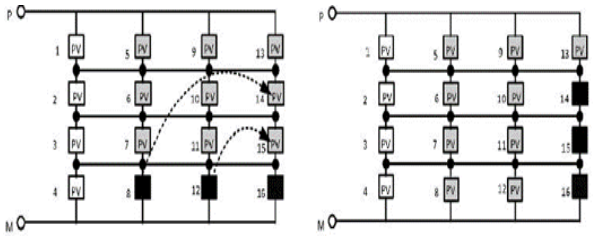


Fig. 3. Irradiance equalization system: dynamic and fixed array

The operating principle of the reconfiguration systems made of a fixed and a dynamic part is essentially the same. The results of are satisfactory, however, the main disadvantage is the high amount of switches and the complexity of the switching matrices. The algorithm are executed several times in a given time interval. This is done to ensure that the reconfiguration occurs only after the verification of the shading condition and to avoid unnecessary reconfiguration

DES (Dynamic Electrical Scheme) proposed is fully dynamic and allows different types of PV modules configurations. The proposed architecture allows the implementation of $\frac{(n*n)!}{(n!)n}$different configurations, where 'n' is the number of modules of the PV array. To avoid the compatibility problem with a frequency inverter, the control algorithm includes limitations as minimum and maximum number of rows allowed in the association.

In fully dynamic arrays, the arrangements generated by permutation between modules, are often redundant. To reduce the number of arrangements and consider only the settings of interest, the COI (Configurations of Interest) parameter, which determines the amount of settings that effectively produce different results. Now to implement the irradiance equalization method, the array can have its dimension modified. However, the optimization algorithm ensures that all rows have the same number of modules. Fig. 5 illustrates the rearrangement process of the shaded modules in a 4x4 matrix.



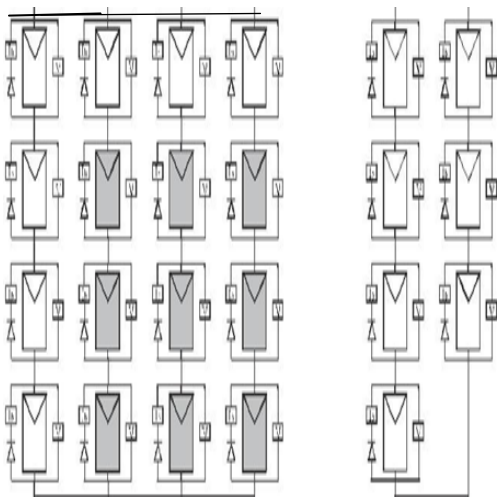
(a) (b)

Fig. 4. Rearrangement of shaded modules: (a) before; (b) after system reconfiguration.

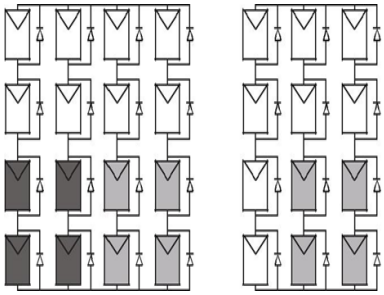
B. SP topology reconfiguration system

In PV arrays with SP topology, the array reconfiguration process is based on the shaded modules grouping. Modules with similar irradiance levels must be connected in series and the resulting rows are connected in parallel.

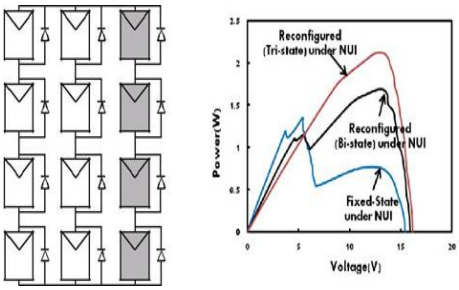
For the array reconfiguration process, first necessary thing is to identify the condition of all PV array modules. This is done by identifying the condition of the PV module by analyzing the current and voltage levels of each module. In this paper, considered a threshold of 15% to enable the PV array reconfiguration, i.e., recombination occurs only when more than 15% of the PV modules are shaded and when values is below threshold, reconfiguration does not produce significant results. Fully shaded modules are removed from the association, since its contribution is considered negligible, and the remaining modules are grouped in an SP (Series-Parallel) arrangement.



Now the PV modules are classified into three different irradiance (G) levels: bright (600 < G < 800 W/m²), gray (400 < G < 600 W/m²) and dark (G < 400 W/m²).



(a) (b)



(c) (d)

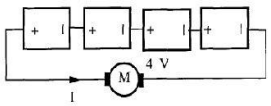
4x4 SP array tests (a) Fixed-State; (b) Bi-State; (c) Tri-State; (d) Comparison of the system power output for the three methodologies.

C. Application based reconfiguration system

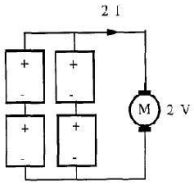
In the previous sections, PV modules are interconnected in an SP (series-parallel) or TCT (total cross tied) arrangement. The mentioned ways over there, where the best possible option is to connect the PV modules in a more flexible way. In these conditions, the reconfiguration process may produce different PV array structures or arrangement electrically, according to the shading profile.

The study developed by Salameh presents a motor pump that operates with an EARC (Electrical Array Reconfiguration Controller) system. Under shading conditions, the array can be connected in three different ways, according to the irradiance level.

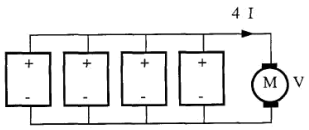
1- Low irradiance: series connection between modules Fig.(a);
2- Average irradiance: series-parallel connection between modules Fig. (b);
3- High irradiance: parallel connection between modules Fig. (c).



(a)



(b)



(c)

Since the configuration topology of the PV array can be changed depending on the shading profile, there are many different possible connections. In the control algorithm changes the symmetry of the PV array regarding the number of rows and columns as needed.

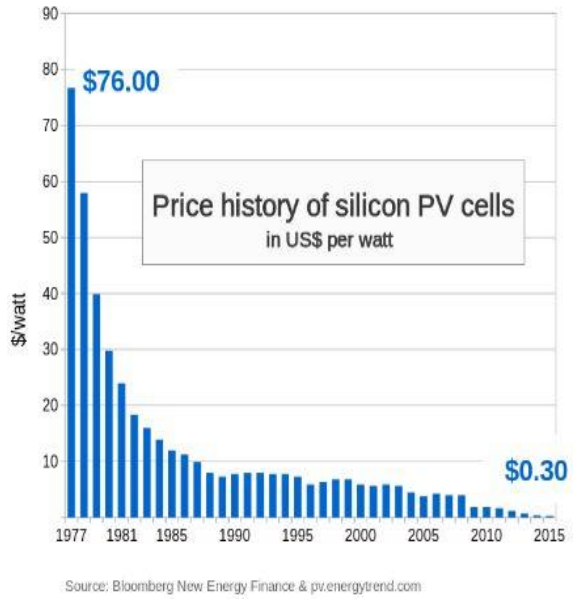
The plausible definition of the ideal configuration takes into account possible load restrictions, that governs to define the number of series (voltage setting) or parallel (current setting) modules. In this work, experimental tests are carried out.

Conditions that require loads with constant voltage or current, as well as constant resistance loads, are evaluated. In all conditions, the system performance has been remarkably enhanced.

III. COST AND ECONOMY

The cost for production of PV cells have dropped due to mass scale production and technological advances in manufacturing. Especially in case of large scale installations of Solar PV, the prices is below INR100 per watt installation and also benefited by government subsidies for domestic and commercial installations in India. The decrease of 50 % in the price is achieved from 2006 to 2011 and also there are chances to lower the generation cost by 50% by 2020. The crystalline silicon solar cells has largely been replaced by less expensive polycrystalline silicon solar cell and by thin film silicon solar cells. The production cost of such solar cell have also been reduced recently. Although they are reduced in energy conversion efficiency from single crystalline "silicon wafers" they are also much easier to produce at considerably lower costs.

The financial assistance is provided by MNRE (Ministry of New and Renewable Energy) for solar roof top PV system in terms interest subsides on loans and/or through providing direct capital subsidy. A capital Subsidy of 30 % of the benchmark cost or project cost for all general category states and union territories and up to 70% of the benchmark cost for special category states is being given to residential, institutional, social sector. Whereas these subsidies are not applicable for commercial and industrial sectors. Government institute including public sector undertaking (PSU) are eligible for achievement-linked incentives and awards. Also concession on import duty/excise duty. Loan is also provided at subsidies interest rate from public sector banks.



The annual output energy is expected in kWh as from each installed kWp of solar modules. This annual energy output varies by geographic locations because of the average insolation depends on the average availability of clear sky (or cloudiness), the density of atmosphere and also depends on the sun's path relative to the panel and the horizon. The PV Panels are usually mounted at the tilt angle dependent on latitude, and often adjusted seasonally to meet the changing Sun's path (or solar declination). Solar tracking can also be utilized to access even more perpendicular sunlight, thereby increasing the total energy output.

If solar power plant is few kilowatts than the maximum return of investment period is 8 months - 1 year and for big megawatt solar plant the ROI is 8 – 10 years.

IV. CONCULSION

Thus there required more research in this sector for pioneering this technology as in terms in finding some low cost alternative methods or making the available methods at lower cost of application. So thus it may become possible to install PV power plant equipped with such array reconfiguration techniques at lower cost and with increasedefficiency.

Thus helps in reducing the time period for return of interest (ROI) asit is observed, remarkable growth in output of the solar PV system by implementing such PV array reconfiguration techniques

It is clear that, in terms of power generation, the reconfigurable PV array has a great advantage over the array with static connections. This issue has influenced the development of several reconfiguration methodologies. But in terms of cost effectiveness of any reconfigurable methodology is mainly dependent on what type of algorithm it uses and also extra components required and their maintenance cost and thus with help of government subsidies it would be possible to achieve the target of 20 GW generation through solar PV in India by 2022.

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