Journal of The Gujarat Research Society

ISSN: 0374-8588
Volume 21 Issue 10, October 2019

Design, Operation and Maintenance of PV Systems: A Review

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ABSTRACT: Renewable technology is becoming increasingly important in the production of electricity nowadays. As they are non-renewable sources of energy that lead to environmental emissions, fossil fuels do not offer a viable choice for the future.Photovoltaic energy is the most commonly used source of green energy, and this is attributed to the vast amount of solar power across the world. The major developments in photovoltaic systems (regardless of the performance of the various technologies) are currently focused on improving the architecture of photovoltaic systems, and also the efficient operation and maintenance of these systems.This thesis aims to study photovoltaic systems, where the key points of these systems are architecture, operation and maintenance. The essential elements of the device and their own configuration are updated throughout the design. The basic operation and the operation of hybrid systems, and also the power efficiency, was checked with respect to the operation. Ultimately, their efficiency, thermography and electroluminescence, soil, hazards and failure modes were studied in relation to the maintenance of PV systems.

Keywords: Design, Installation, Maintenance, Photovoltaic, Renewable, Solar Energy, Alternate source.

INTRODUCTION

Renewable energies are an actuality in the electricity power landscape, as described in the abstract. Reducing CO2 emissions and enhancing the effectiveness of renewable energy technologies are among the core components of their integration into electricity grids [1].The use of electricity is a fundamental necessity around the world today. As said above, owing to the increase and expansion of societies, the global usage of electrical resources is growing. Fossil fuels, while they are non-renewable energy sources and lead to environmental waste, are not a sustainable choice for the future.Therefore, the usage of non-renewable resources has to be limited, with renewable energies having a significant role in the future. Solar energy is the most commonly used in the world at this time and, however, it is pure and without noise[1]. The above features makes photovoltaic technology one of the green technologies that is most wanted. By the end of 2015, it had installed approximately 230 GW of photovoltaic capacity. In recent years, there has been a growth in the construction of photovoltaic solar plants and high-power installations[2].

To achieve high efficiency in the production of electricity, the design of photovoltaic plants is important. To achieve this, it is important to ensure the efficient operation and maintenance of photovoltaic plants. The process maximises the plant's productivity, while maintenance makes it more productive, since it is easy to detect low rate of development and deficiencies. In consideration of the above, this work aims to investigate photovoltaic systems, where the secret to these systems is design, operation and maintenance.

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ISSN: 0374-8588
Volume 21 Issue 10, October 2019

DISCUSSION

The criteria used to assess the evolution of the various installations are: regular energy provided on the Alternating Current (AC) side, annual efficiency, reference performance, and performance ratio. It is derived from the evaluated data that 3 facilities are exceptional, 5 facilities have bad performance and the remainder have average performance. Basic recommendations for the design, implementation, and maintenance of solar photovoltaic systems are determined from the results obtained[3][5]. The instructions for the specification, installation and maintenance of PV systems after review are seen in Table 1.

Table 1. Design, Installation and Maintenance for PV systems

Component/ Guidelines	Design of PV systems	Installation of PV systems	Maintenance of PV systems
PV Module	All technologies are valid, but it is necessary to payattention to their efficiency and cost. In addition,manufacturers' specifications do not always coincide with laboratory and field experiments	To guarantee the ventilation (cooling) of thephotovoltaic modules installed on roofs, it isnecessary to guarantee asufficient spacebetween them and those	As a general rule, to be able to estimate the photovoltaic production, the maintainers use the real measurement coming from the Smart Meter. This measure of production must coincide with the irradiance existing at the site, so it is convenient to have irradiance meters[4]
Inverter	The best configuration is one that does not have atransformer associated with the inverter. The action of the MPPT must cause the voltage tomove to high values, and in this way reduce thecurrent values (and therefore the losses)All commercial investors guarantee an acceptableTHD and power factor	The ideal cabin is one that maintains a constanttemperature (10–15 °C)	
Shading, Obstacles and Parts	The tools for the evaluation of shadows arefundamental. Some of these tools are: PVSyst,Autocad, SketchUp, etc.	The existing elements must be valued, since theycan be obstacles and shadows for the system. Airconditioning	The checking of the status and operation of circuit breakers, fuses and other elements must be carried out by the service personnel The task of cleaning the

ISSN: 0374-8588
Volume 21 Issue 10, October 2019

		systems must also be taken into account	photovoltaic modules is critical, since the dirt is responsible for a high degradation in the efficiency of the module In the systems with follow-up (one or two axes), the lubrication and supervision of the moving parts is necessary[5]
Inverter-PV Array	Experience shows that the optimal configuration isthe one with the largest number of modules, inorder to allow more branches in parallel. In the design phase, it is advisable to propose anoptimum inclination of modules according to the location, and the models should be calculated with a maximum irradiance of 1100 W/m2 withmaximum periods of 15 min[6]		
Electric Cables	On the DC side, it is necessary to have fuses andcircuit breakersThe AC cables must have double insulation and oversized sections	The cables must avoid being exposed to the sun,and the protection boxes must be watertight. Itmust be taken into account that the componentsneed to dissipate heat in their normal operation[7]	To avoid the increase in losses, the cables and the inverters must have low temperature

CONCLUSION

An analysis of the architecture, installation and maintenance of photovoltaic systems has been requested. It has been analysed how, at current, the greatest developments in photovoltaic systems are based on improved designs of photovoltaic systems, and also optimum operation and maintenance, which are the core aspects of research into PV systems. The essential components and the architecture of systems have been studied in relation to the PV system design. It has been concluded in the publications reviewed on converters that new models of converters are needed. In their producing energy, these converters need to be more effective. Modularity and simplicity are desirable qualities, in addition to greater efficiency.

It has been shown how an optimal way to constantly provide electricity is to use storage systems to replace the batteries that are currently used systems but with higher costs and limited lifetimes. The strategies described were linked to utilisation of scale, traditional compressed air and the use of pumping systems. It has been shown that retaining good performance values is quite necessary in order to achieve the maximum output values and therefore to attain, on the one hand, better solar panel efficiency and, on the other hand, cost optimization.With respect to operation and repair, some of the papers are focused on the detection, diagnosis, examination and classification of frequently occurring faults in order to mitigate control and maintenance activities. Various types of sensors, autonomous devices with thermographic cameras (drones), training algorithms used in artificial neural networks, two-level hierarchical control technique with fuzzy logic and MATLAB/Simulink based environmental evaluation and control could be used for this reason.

With regards to the maintenance of PV systems, their efficiency, thermography and electroluminescence, soil, hazards and modes of failure were examined.A few specific things have been identified that can be taken into account in order to identify the cause of losses and thus minimise the poor energy production operation, in situ field inspection, irradiation sensor detection, power generation assessment, photovoltaic module checking, photovoltaic string testing, use of thermographic and electroluminescence camera, monitoring of energy production, photovoltaic module testing, photovoltaic string testing, use of thermographic and electroluminescence cameras.

In order to ascertain the optimal washing time of the photovoltaic panels, a local analysis was carried out and the depletion of energy and current due to dirt by dust was analysed in the exposure cycles of a day, a week and a month, with the average deterioration rate of the efficiencies of the modules subjected to dust being: 6.24%, 11.8% and 18.74%, accordingly. We propose monthly servicing of the mounted panels. It is preferable to use nano-coated material to minimize water usage in the washing and heat failures within the module in order to prevent such concentrations of dirt.All the papers presented aim to maximise efficiency and reduce operational and repair costs. This problem can be solved by impacting the various elements of which a photovoltaic device comprises. The most popular are the converters, the quality management of the power produced, the issue of the modules' lack of output due to meteorological factors (dirt and shading), the formation of hot spots and the snail track.

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