International Journal for Research in Engineering Application & Management (IJREAM)
ISSN : 2454-9150 Vol-04, Issue-07, Oct 2018

Design of solar power plant with optimum voltage generation

Mr. Shravankumar Venumula, Ph.D. Student, Bhagwant University, Ajmer, India,

Shravan.gnits@gmail.com

Mr. Shiva Kumar Nomula, Ph.D. Student, Bhagwant University, Ajmer, India,

shiv.solar@gmail.com

Abstract—Since conventional energy sources are going to end due to increased demand for power consumption, we need to look for efficient power generation plants using non-conventional sources to meet the day to day demand. There are some developments in power generation using N-CES such as solar power plants, wind power plants, geothermal plants, etc. Specially, plants using solar energy having time to time new challenges to develop the optimum voltage with maximum power which includes design of PV cell, design of inverters, plant orientation, cleaning the cell panel, etc. Besides, considering reactive power requirement, balanced voltage and maximize solar radiation, the system need to be designed optimally. Without disturbing grid voltage stability with maintaining system reliability and power quality, the new proposed plant must contain suitable designed models for all types of load conditions. Simulation software tools can be used to find the required model desired output and to observe behavior of the designed models which are considering with different issues such as daily power demand, voltage surges and switching to distribution systems etc. with the facilitation of static and transient reactive power for application at low to high voltage, and the control issues deployed with plant reactive power and control of voltage are also major issues in the design. The paper will describe on the major technical considerations and design a model of solar power plant with optimized voltage generation.

KEYWORDS — **Generation of solar power, Optimum voltage generation, Plant orientation, Reactive power, Power quality.**

I. INTRODUCTION

The radiation from solar is the radiant light energy and temperature from sun can help to generate electrical energy by modern techniques. The radiation from solar is the radiant light energy and temperature from sun can help to generate electrical energy by modern active solar techniques, such as Photo voltaic cells, concentrated solar power etc. Approximately 174 $*10^{15}$ watts radiation received by the earth from the sun which is available by natural and sustainable. Power generation using solar power plants is increasing in worldwide rapidly.

In 2010, Ministry of New and Renewable Energy (MNRE) [2], India has launched National Solar Mission to install and generate 20,000 MW and connect to grid to meet large power demand as well as 2,000 MW small plants to meet low power applications with 20 million solar lights by 2022.

In 2010 solar plant arrangements in the USA were up more than double of 2009 [3]. Power generation using Photovoltaic (PV)cells observed more with different types of applications and grid connections. The largest solar power generation is in India with 1000 MW and it was commenced in 2017. It is Kurnool Ultra Mega Solar Park [4]. These big power plants required to design in such a way that it should meet the necessary reactive power capability and generate maximum possible voltage.

II. DESIGN OF SOLAR POWER PLANT-ORIENTATION

In solar power plants, solar panels (PV) are arranged in arrays and the output of each array is connected to a common DC bus. Then, The DC bus will be connected to an inverter and then to step-up transformer. Figure 1. Shows the layout of solar power plant using 3-phase inverters with Voltage regulators, and STATCOM. Output from an inverter connected to a step-up transformer (Star-delta) to step the voltage up from 3- phase 415V Vac to 3-phase 11kV Vac. It is designed such a way that from low voltage DC to High voltage AC conversion is as per the National Electrical code standards [5].

Earthing: for low voltage plants, as per the standards of NEC, Photovoltaic arrays are connected to earth at a single point along with equipment earthing.

 DOI : 10.18231/2454-9150.2018.0978

For medium voltage plants, earthing will be done as per standards of NEC and NESC [6]. Based on the inverter design, the earthing of transformers is done. The design of inverter as per the standards of IEEE 1547/UL 1746 [8] with 0.9 lag to unity power factor to meet the reactive power requirement and to bear the surges in voltages.

To maintain the power quality of the grid, STATCOM (FACT device) with capacitor banks is used which consists of dynamic reactive power capability and to face voltage surges. Connecting STATCOM [9] device just before grid connection is the solution for already installed plants where it is required to improve power quality.

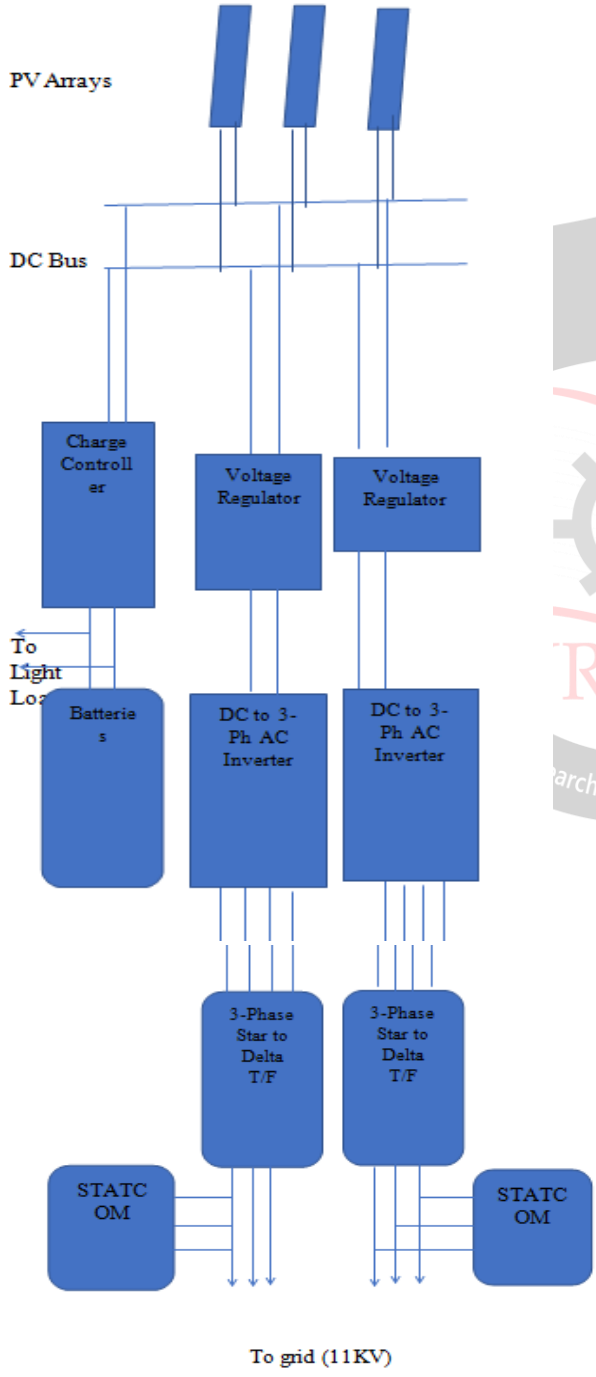

Fig1: Layout of Solar power plant and orientation

Voltage regulators are used as per the standards of IEEE 1547/UL 1741 to maintain proper input to inverters from DC bus. Star-Delta transformer is used to step up the voltage to grid voltage for interconnection.

Charge controllers are used to maintain proper charging to batteries, and this can be used for small loads like lighting at plant, etc. Batteries are used li-ion type, and they need a regular maintenance service to avoid malfunction or damage of batteries

III. IMPLEMENTATION AND ANALYSIS

A. Solar Photo voltaic arrays:

As maximum possible voltage or optimal voltage from a solar PV cell is limited to its design, irradiance, and temperature. Hence, it is required to connect the required number of cells in series framing an array. Figure 1 shows a model representation of 24 panels in each array and the output voltage of each array will be 36.3V of 250W. Using Simulink software, in each panel. 36 PV cells are designed by using simelectronics blocks. An average solar radiation 1000 W/m^2 with 27^{o}C temperature are used as inputs to PV panel to observe optimum voltage

B. Voltage regulators:

Voltage regulators are designed as per the standards of IEEE C57.15-2009 [10]. To regulate the input voltage to inverters as it needs a constant DC voltage to invert to 3-phase AC 415 V.

C. 3-Phase Inverter:

3-Phase inverters are designed as per standards of IEEE 1547/UL 1746. The output voltage from an inverter is 415V. The necessary filters are considered as per standards of IEEE 1547/UL 1746 to avoid harmonics distortion.

D. 3-Phase transformer:

Design of step up transformer is asper the standards of IEEE C57.12.00.2010 and it is designed as star-delta transformer to step up the voltage to grid level voltage.

E. D-STATCOM

Dynamic reactive power static compensators (FACT device) are used to support system voltage stability and to maintain system power factor at desired value. These are designed as per the standards of IEEE1547/UL 1746.

PV solar power plants using are designed for transmission system interconnection and should meet the required reactive power and control of voltage requirements. D-STATCOM provides required dynamic reactive power at the point of interface. Switching capacitor banks can be used for bulk power rated plants.

Simulink software is used to analyses the results. Simelectronics blocks were used to design a solar panel, voltage regulators and 3-phse inverters whereas simpowersysetms were used to design DC bus, STATCOM and grid.

IV. CONCLUSION

In this paper, a solar power plant layout with necessary components to develop optimum voltage generation to meet

 DOI : 10.18231/2454-9150.2018.0978

power demand is designed. Simulink software was used to observe the DC bus voltage as well as inverter output voltage.

REFERENCES

[1] https://en.wikipedia.org/wiki/Solar_energy

[2] https://mnre.gov.in/

[3] RenewableEnergyWorld.com Editors, "US Solar Industry Grows Despite Economy," available at http://www.renewableenergyworld.com/rea/news/article/2010/10/ussolar-industry-grows-despite-economy.

[4] https://www.nrdc.org/experts/anjali-jaiswal/worlds-largest-solar-park-kurnool-india

[5] IEEE Standard for Interconnecting Distributed Resources With Electric Power Systems, IEEE Std 1547-2003.

[6] NFPA 70: National Electrical Code®.

[7] National Electrical Safety Code (NESC®).

[8] UL Standard for SafetyInverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources, UL 1741.

[9] Ben Kroposki, "Distribution System ModelsPower System Studies and Modeling PV Inverters," Utility/Lab Workshop on PV Technology and Systems, Tempe, Arizona, November 8-9, 2010..

[10] Solar Power Plant Design and Interconnection E.H. Camm, Member, IEEE S. E. Williams, Member, IEEE

 DOI : 10.18231/2454-9150.2018.0978