Performance Characteristics of Multilevel Converter in Grid Connected System with Renewable Energy Resources

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Abstract: **The multi-stage cascade converter structure can be fascinating for high-performance solar photovoltaic (PV) systems due to its interchangeability, expansion, and MPPT (Maximum Power Point Tracking) exception. However, power discrepancies in cascaded uniform PV converter modules can cause unstable voltages and system operation. This article highlights the problem, examines the effects of reactive power compensation and optimization on the safety and performance characteristics of the system and proposes a synchronized distribution of active and reactive power in the network in order to reduce this instability. Furthermore, a wind turbine is connected in parallel to the photovoltaic system to increase the reliability of the system. This document presents the standards and specifications of grid-connected photovoltaic inverters and the different topologies of grid-connected photovoltaic inverters. And he also discussed monitoring maximum credit points.**

Keywords: MPPT, DC, AC, invertor.

I. INTRODUCTION

With the increase in population, the demand for energy and therefore for solar energy could prove to be a truly efficient and sustainable source of energy compared to other types of energy sources such as wind, tides. , etc. Solar energy is a type of energy that converts solar radiation into electricity. A solar system is made up of solar modules. The number of cells is combined in a single module and these modules are in turn connected to form the photovoltaic system. A grid-connected photovoltaic system or grid-connected photovoltaic system is a solar power generation system that is connected to the electrical grid. A grid connected PV system consists of solar panels, one or more inverters, a power conditioner and grid connection equipment. In an interactive or grid-connected system, the grid-connected inverter plays an important role, controlling the flow of electricity from source to load and can be implemented with or without MPPT to monitor power maximum solar modules possible. The block diagram of the connected photovoltaic system is shown in Fig.1. The main objective of this document is to simulate a single-stage inverter connected to the grid with MPPT to extract the maximum power and compare the results for the same system without MPPT.

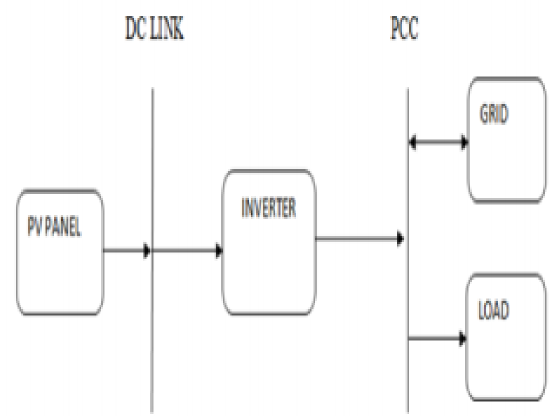

Fig 1. Single line diagram of grid interactive photovoltaic power generation.

II. LITERATURE REVIEW

J. Sastry et al. [1] In this thesis, the cascaded H-bridge inverter (CHB) is evaluated as a PV power conversion solution for large-scale photovoltaic systems. The advantages and disadvantages of the CHB inverter for large-scale photovoltaic systems are discussed. The comparison between CHB and conventional central inverters is also presented in terms of efficiency and cost. Benchmarking shows the promising benefits of using CHB inverters for large-scale photovoltaic systems.

A.Águila Téllez et al. [2] In this thesis a complete bibliographic review of the mathematical methods for the optimal selection and localization of the reactive power compensation elements is developed, the results of different authors for different objective functions are analyzed and a scientific problem is identified in the conflict that the electrical variables they are displayed if analyzed individually; This shows the need to analyze this problem on different criteria and to consider distribution network topologies with distributed production and energy storage.

C. Guo et al. [3] this article develops a single-phase reactive power compensation control for the static compensator (STATCOM). The main novelty is that STATCOM's reactive power compensation is reformulated as an equivalent follow-up control for reactive current, and a new estimator for unknown system dynamics (USDE) is explored to handle unknown system dynamics. Initially a modeling phase is carried out starting from a basic single-phase STATCOM structure and the STATCOM principle to describe its behavior. To counteract unknown dynamics and external disturbances, a new USDE is then developed so that modeling uncertainties and external disturbances can be taken into account without the use of a function approximate, whereby the computational costs The demanding parameterization and laborious in other control schemes is eliminated.

L. Liu et al. [4] this paper discusses these issues, examines the effects of reactive power compensation and optimization on system reliability and quality, and suggests coordinated distribution of active and reactive power to address this problem. First, a vector method is developed to illustrate the principle of energy distribution. As a result, the relationship between power and voltage is analyzed with a wide operating range. An Optimized Reactive Power Compensation (RPCA) algorithm is then proposed to improve stability and reliability of system operation and to facilitate MPPT implementation for each drive module at the same time.

III. Standards and Specifications of Grid-Connected PV Inverter

Distribution system operators are responsible for providing their customers with safe, reliable and high quality electricity. The PV industry should be aware of energy safety and quality issues and help set standards, as this would ultimately lead to greater acceptance of grid-connected PV inverter technology among power industry users. In order for the system to function safely and reliably, these standards must be adopted, which increase the confidence of electricity consumers, reduce costs and further promote the development of grid-connected PV inverters. There are several standards on the market that deal with connecting photovoltaic energy sources to the public grid, such as the International Electrotechnical Commission (IEC), the Institute of Electrical and Electronic Engineering (IEEE), and the National Electrical Code (NEC). .

These standards set the limit values for the inverter voltage variations, its variations in the operating frequency, the power factor, the harmonics of the current fed into the grid and the supply of direct current into the grid to avoid saturation of the distribution [5] and also address grounding problems. They also contain information on isolating PV systems when the grid supply is not connected to the inverter control voltage and frequency, as well as techniques for avoiding isolation of power sources. Photovoltaic energy. In the island state, the power grid has been removed from the inverter, which supplies electricity only to local loads. In addition to these standards, there are a few others, of which IEEE 1373 recommends the practice of field test methods and procedures for networked photovoltaic systems. IEC 62116 recommends testing procedure for insulation prevention measures for grid-connected photovoltaic inverters (IEC) The 61173 standard contains guidelines for surge protection for photovoltaic power generation systems. The IEC 61683 standard recommends the method for measuring the efficiency of the photovoltaic system.

IV. Different Topologies of Grid Connected PV Inverter

In the grid-connected PV system, the DC power of the PV generator must be converted into AC current with the correct voltage, frequency and phase to be connected to the grid. In this condition, a DC / AC converter, better known as an inverter, is required. Below are different types of grid-connected photovoltaic inverters, as shown in Fig. The line switching inverter, where the power grid determines the switching process (the switching process is initiated by reversing the polarity of the AC voltage) , uses power switching devices such as switching thyristors. The device power on operation can be controlled from the device port, while the device power off operation cannot be controlled. Such a device is turned off using an additional circuit to the device. In contrast, the self-switching inverter, in which current is transferred from one switching device to another in a controlled manner, is distinguished by the fact that it uses such a device that can control it. B. an insulated gate bipolar transistor (IGBT) and a metal oxide semiconductor field effect transistor (MOSFET). Power MOSFETs are used for low power, typically less than 10kV, and high frequency switching (20-800kHz), and IGBTs are used for medium to high power, greater than 100kW, but switching at very high frequency is involved. IGBT frequency is not possible Frequency switching is limited to 20 kHz. Grid connected inverters require high frequency switching to reduce the harmonics of an inverter's output current, the size of the magnet (filter) used and the weight of the inverter.

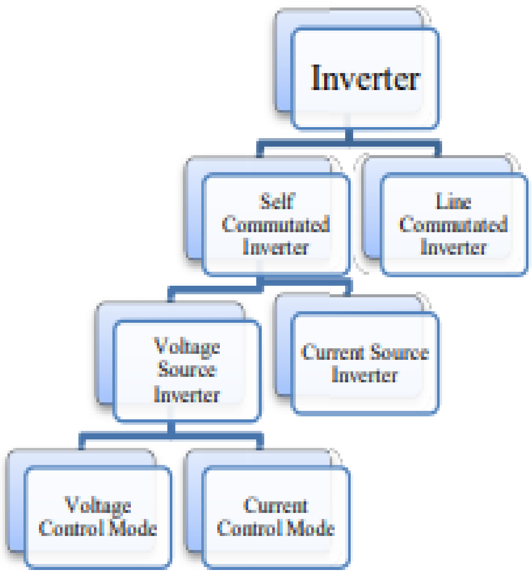

Fig. 2 Classification of inverter type

The Auto Switching Inverter uses Pulse Width Modulation (PWM) switching technology to create an AC output waveform. The auto switching inverter can control both the voltage waveform and the current waveform of the output side of the inverter and adjust or correct the power factor and remove harmonics in the form of current waves, necessary for a photovoltaic system connected to the grid and very resistant to disturbances from the electricity grid. Nowadays, most inverters for distributed power systems such as photovoltaic systems use automatic switching inverters instead of the line switching inventor due to the development of advanced switching devices such as power MOSFETs and IGBT..

V. PROPOSED METHODOLOGY

The electrical system, which includes solar and wind power, is known as a hybrid propulsion system, which offers several advantages over any single system.

Just like the sun's rays, wind is also available over the entire earth's surface. The difference in atmospheric pressure causes the wind to blow. Wind energy is regenerative, abundant, readily available, and pristine. It does not produce harmful gases, does not require water and can be built on a small area.

Wind turbines convert the kinetic energy of the wind into mechanical energy using wind turbines. This mechanical energy is converted into electrical energy by a generator. Wind turbines can have a horizontal or vertical axis. These can be fixed speed turbines or variable speed turbines.

The combined wind and solar power system known as the hybrid power system has several advantages over one of the functional power systems. In the summer the wind is weak while the sun is the brightest, and in the winter there is a strong wind but the sunlight is weak. The solar wind system therefore leads to the availability of electricity at all times.

Conversion/ Controller stage:

Under the two sources of strength; solar power indicates the DC output voltage and wind energy indicates the AC output voltage. In the conversion phase, wind energy is converted into direct current. This combined output is sent to the regulator stage, which controls the input voltage and supplies the constant voltage on the output side.

Distribution Stage:

This is the last stage where energy is distributed to homes and industries for effective use. This electrical energy can be fed directly into the grid or stored in the batteries.

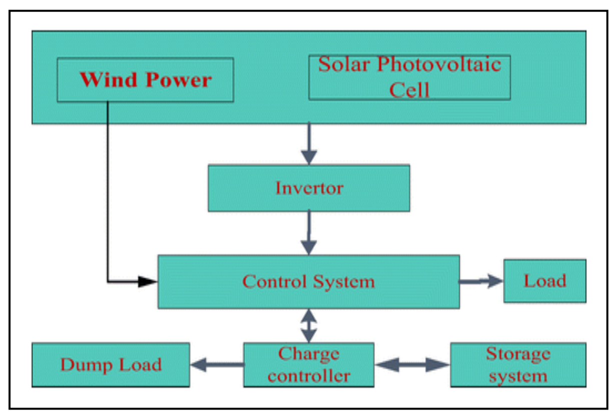

Fig. 3 Architecture of PV–wind hybrid system

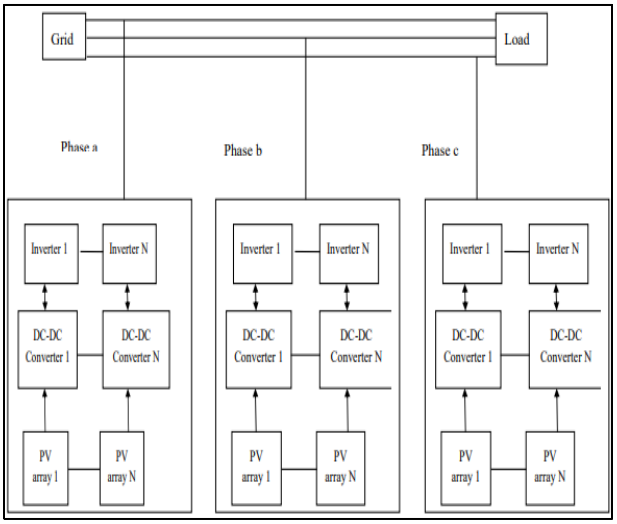

Fig. 4 Block diagram of Grid-connected PV system with Cascaded PV inverters.

The PV system shown in Figure 4 contains n cascaded multi-cell inverter modules for each phase, with each inverter module connected to a single DC / DC converter with high voltage isolation. The DC / DC converter is connected to single photovoltaic panels and therefore the independent MPPT can be obtained. Furthermore, it is immune to the propagation of double frequency power ripples in photovoltaic panels. It can also solve the problems of earth leakage current and photovoltaic insulation. The detailed design of the DC / DC converter with large input area is shown. The focus here was on the active and reactive control of multi-level cascaded PV inverters. The selected PV application is a 3 MW / 12 kV PV system. We choose n equal to 4, taking into account the compromise between costs, duration, and choice of capacitors and switching devices, switching frequency and power quality.

VI. Maximum Power Point Tracking

It is a DC-DC converter which increases the compatibility between a PV cell and a battery or receiver. Converts the high-value DC voltage from a PV array to a lower-value voltage required at the end of the link. Usually power conversion is never 100% and without MPPT, about 35% of power is lost when stored in a battery. MPPT can increase this storage process to 15% in winter and 35% in summer. Systems connected to the network with MPPT have a competence from 94% to 97%. Although the payment is highly dependent on weather conditions, temperature, battery location, etc.

The Power Point Tracker is a high frequency DC / DC converter. They take DC input from solar modules (or AC from wind turbines), turn it into high frequency AC, and convert it back to another DC voltage and current to match the modules exactly to the grid voltage. MPPTs operate at very high audio frequencies, typically between 20 and 80 kHz. The advantage of high frequency circuits is that they can be built with very high efficiency transformers and small components. Designing high frequency circuits can be very difficult due to problems with parts of the circuit that "transmit" just like a radio transmitter causing radio and television interference. Isolation and noise suppression become very important.

There are non-digital (i.e. linear) MPPT charge controllers. These are much easier and cheaper to build and design than digital ones. They improve efficiency somewhat, but overall efficiency can vary greatly and we have seen some lose their "tracking point" and even get worse. Sometimes this can happen when a cloud is moved to the panel. The linear circuit searches for the next best spot, but is too far from the bottom to be found at dawn. Fortunately, there aren't many left.

Power point tracking technology is used in power electronics converters to convert DC input, convert it to AC through a transformer (usually a toroid), then back to DC through a rectifier, and power the output to a regulator. MPPT is generally an electronic process. Recently, microcontroller-based MPPT controllers have been developed to regulate the output on the battery by observing the battery and the PV cell adjusting their input to produce the required output voltage.

VII. Conclusion

This article discussed the effect of reactive power on grid-interacting solar and wind hybrid system with cascade inverter. The wind turbine is connected in parallel to the photovoltaic system to ensure continuity of power supply and the DC-DC elevator converter is used to achieve uniform performance. The voltage of each PV generator is individually controlled by the MPPT algorithm. In addition, a uniform power flow regulator is used on the grid side to compensate for reactive power. The effect was analyzed and an optimization method proposed to improve power quality and system reliability. The approach to improve overall system stability and dynamic behavior is demonstrated.

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