GRID-CONNECTED WIND-SOLAR COGENERATION WITH BACK-TO-BACK VOLTAGE-SOURCE CONVERTERS: MAXIMIZING RENEWABLE ENERGY INTEGRATION

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ABSTRACT: The novel configuration for a grid-connected wind-solar cogeneration system is described in this study. The defining characteristics of the proposed topology are its simplicity and exceptional efficiency. The utility grid is connected to a wind turbine that is outfitted with permanent magnet synchronous generators and back-to-back voltage-source converters (VSCs). Using the dc-link capacitor, a photovoltaic solar generator was directly connected to the system. The simplification and effectiveness of the hybrid system are enhanced by the elimination of dc/dc conversion phases. The suggested configuration integrates a technological system that monitors the optimum power points of wind and solar generators in order to optimize the harvesting of sustainable energy. In the rotating reference frame, the VSCs are governed by vector control. Component-level small-signal model construction determines the system's overall stability. Additionally, the operational effects of utility grid disruptions on the proposed system are investigated in depth. Effectiveness of the proposed topology is demonstrated through the presentation of simulation outcomes in the nonlinear time domain for various operational scenarios.

***KEYWORDS*:**VSC, VSI, PI controller, Power quality.

1.INTRODUCTION:

The low cost and high efficiency of wind generators have kept them popular as a means of powering devices with natural energy. The inconvenient fact that renewable energy sources aren't always available when needed is a major drawback of using them. The proliferation of green power has hastened the process of creating and utilizing energy combinations. Digital power inverters regulate both active and reactive power as well as frequency. Additionally, they maintain a consistent grid voltage even when power is out or dips.

Numerous methods for managing wind generators, both those that connect to and those that operate independently of the electricity grid, have been detailed in literature. The controllers on the device side are responsible for determining the optimal power factor for the wind using hill-climbing, flexible, and fuzzy control approaches. The employment of control mechanisms based on fields or vectors is common.

To guarantee that the grid receives both reactive and dynamic energy, grid-side controllers are required. When investigating issues with voltage and current, electric power systems have made use of several power concepts, such as the rapid power (PQ) idea for an Akagi three-phase system. Thanks to this, the academic framework is now much simpler.

To facilitate the faster separation of dynamic and responsive components, the PQ concept reduces the three-stage referral structure to two stages. An alternative, more generic three-phase power paradigm is the conventional power concept (CPT). According to this theory, there are three ways to determine the current and voltage without modifying the reference frame. These concepts have been put to the test to determine their efficacy.

In order to improve the performance of the grid-side converter in a wind generator system when dealing with single-phase and three-phase loads, this task demonstrates how to configure a control system for a three-phase four-cord system. The CPT is used to generate fresh, up-to-date suggestions for determining disruption payment. In order to locate three-phase, four-wire inverters, four-leg converters or conventional three-leg converters with a "split capacitor" were employed. Through a three-legged conventional converter, the electric omphalos of the DC bus are linked directly to the air conditioner's neutral wire. An air conditioning neutral wire link makes up the fourth button leg of a four-leg converter.

There is a significant power difference between the "split-capacitor" converter geography and the "four-leg" one. Nonlinear masses in the system under investigation can be either well-balanced or not well-balanced, and can be either single-phase or three-phase. Finding and rating a ton's nonlinear, responsive, repellent, and out-of-balance properties across a range of source voltage situations is done using the CPT in a four-wire system.

2.RELATED STUDY

In this article, we will look at a microgrid that operates on electricity from solar photovoltaic (PV) panels and a multifunctional voltage source converter (VSC). This approach enhances photovoltaic array performance by regulating grid currents, decreasing reactive power, minimizing harmonics, and simplifying the transition between grid-connected (GC) and standalone (SA) modes. To maintain load supply in the case of a grid breakdown, this technology swiftly transitions to SA mode. When the grid is back up, GC mode is also activated instantly. That's the job of the VSC: to regulate the voltage in SA mode and the current in GC mode. Whether a solar PV array is charging in GC mode or SA mode, this strategy can maximize its power output.

3.PROPOSED METHODOLOGY

Various methods for wind and solar turbines to detect their peak power points are incorporated into the proposed topology to increase the amount of renewable energy. To keep VSCs under control in a rotating reference frame, vector control is employed. Each component of a system is given its own comprehensive small-signal model in order to evaluate its overall stability. We also consider the possibility that issues with the electrical grid may impact the performance of the proposed system. The proposed architecture is tested in different scenarios using nonlinear time domain simulations.

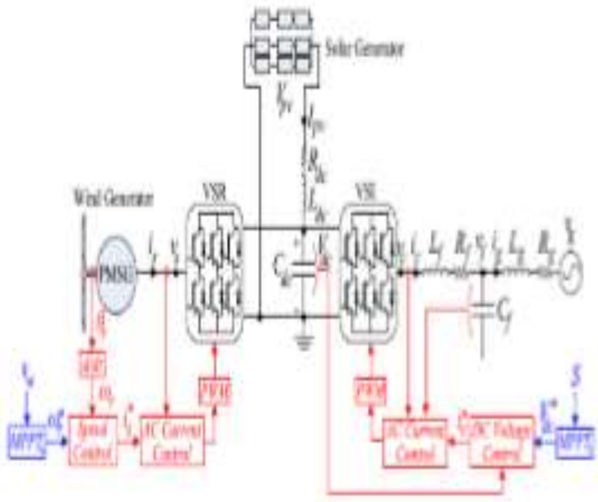

Fig.3.1. Block diagram.

4.SIMULATION RESULTS

Hybrid wind-solar systems demonstrate the efficacy of renewable energy sources when combined with minimal power electronic conversion processes. Nonetheless, there are applications where these technologies are more suited than those that rely on the power grid. The authors of this paper believe that the majority of research has concentrated on methods to link renewable energy sources like wind and solar to the electrical grid.

In order to connect the utility system to the wind and solar generators, the BtB VSC must first set up a link. The dc-link voltage on the machine-side VSC is adjusted by an outer loop proportional-and-integral (PI) dc voltage driver to align with the maximum power-point tracking (MPPT) value of the PV panel. The machine-side currents can be precisely controlled using a hysteresis current driver.

The synchronous detection approach is employed to obtain the reference numbers. The grid-side VSC adds total currents to the power grid using a hysteresis grid-current controller. There are known issues with the proposed technique, despite the fact that it may have certain benefits:

1) A combination of wind and PV power requires both VSCs to be operational. Higher losses and

less dependable system performance may result from this in certain cases. For instance, if the wind speed decreases to the point where it fails to produce any wind power, the machine-side
2) VSC may not be able to maintain track of the PV MPPT's dc-link voltage due to its rapid changes.
3) The machine side controls the dc-link voltage instead of relying on servo operation to directly control the speed of the wind turbine.
4) A change in switching frequency and an increase in harmonics are the outcomes of controlling machine and grid current with hysteresis controllers.

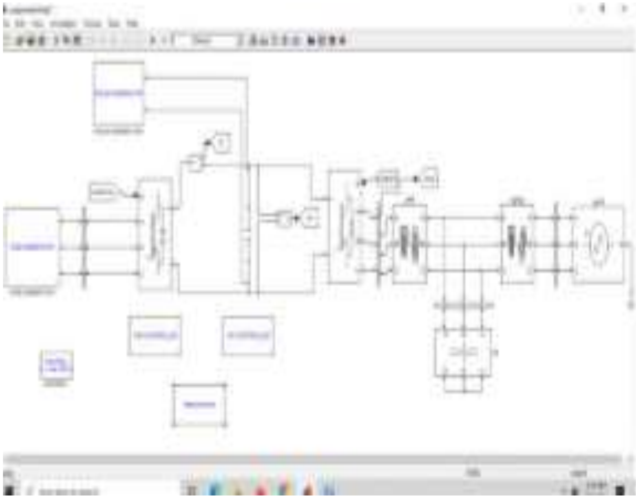

Fig.5.1. Proposed system model.

Fig.5.2. Wind power generation

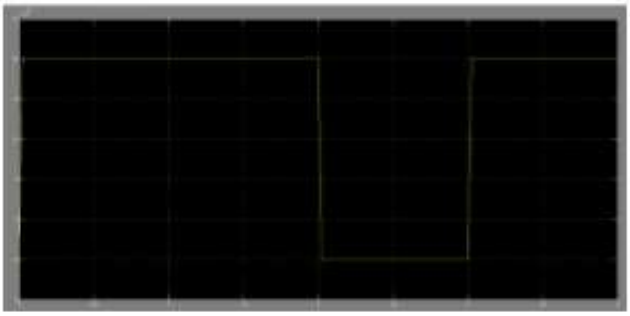

Fig.5.3. PV power at solar panel.

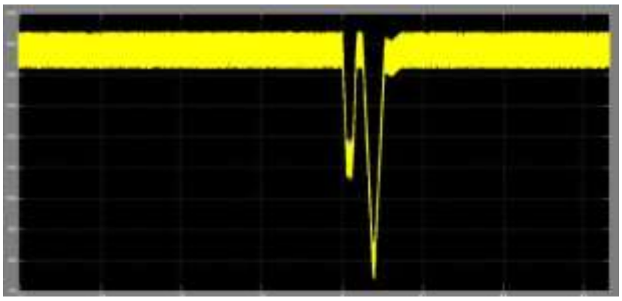

Fig.5.4. Fault applied indication time.

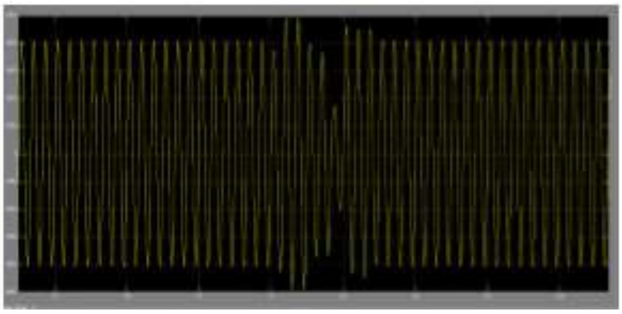

Fig.5.5. Fault applied at grid indication.

5.CONCLUSION

This article describes a grid-connected B-to-B VSC system with vector control that combines wind and solar power. In all operational modes, the wind generator side VSR is responsible for balancing the power entering and leaving the dc-link capacitor and keeping the PCC voltage stable. In order to verify the system's stability, the complete state-space model was constructed using a small-signal linearization method. Utilizing renewable energy sources like solar and wind helps to improve the system's dependability while also reducing its environmental impact. 2) Independent minimum power point tracking (MPPT), with the VSR solely collecting power from wind and the VSI exclusively from PV. (3) The VSI continuously modifies the dc-link voltage, enhancing damped performance. Basics of system organization and controller design. 5) Fault-riding is possible because to the existing safety measures. The system was shown to be operating at its most efficient and damping level using time-domain simulations conducted in the Matlab/Simulink environment. These simulations covered a range of operational scenarios.

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