International Journal for Research in Engineering and Emerging Trends (IJREET), Volume 6, Issue 2, September, 2022
ISSN: 2545-4523 (Online)

A REVIEW ON POWER MANAGEMENT TECHNIQUE HYBRID MICRO-GRID SYSTEMS

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Abstract: To satisfy the ever-increasing needs all around the globe, renewable energy supplies are now the most important alternative to fossil fuels. A reliable power grid relies heavily on the contributions of renewable energy systems. Hybrid systems are emerging because of the unpredictability and fluctuating output of renewable energy sources. Hybrid systems provide a practical answer to the problems of energy storage and power quality. Decentralized power systems are increasingly focusing on energy storage as technologies emerge to allow renewable energy sources to function in a grid-connected, rather than islanding, manner. Systems for managing energy consumption on a microgrid are essential to its reliable and cost-effective functioning. These power management systems are widely used in integrated operational renewable systems, and they use a variety of storage strategies (batteries, supercapacitors, ultracapacitors, multilevel inverters, and fuzzy logic rules). This paper presents a study of the role of power electronic devices and flexible AC transmission systems in relation to grid integration and power quality challenges arising from the incorporation of renewable energy sources into the grid. The latest developments in power electronics for combining wind and PV generators are discussed in this paper.

Keywords: *Photovoltaic (PV), Battery, Super-capacitor, Hybrid Storage, State of Charge, P&O MPPT technique.*

I. INTRODUCTION

Energy storage systems (ESSs) are used in microgrids to provide uninterrupted power from an intermittent source like PV, reduce the power mismatch between the produced and required power, i.e., the smoothing output power mode, and improve the system's quality and stability. The battery is the most common kind of energy storage due to its low cost and simplicity of usage.

Batteries, on the other hand, have a low charging/discharging rate due to their high energy density and low power density. Unlike batteries, which provide rapid charging and discharging, supercapacitors (SC) have a limited energy density and high-power density. To reap the advantages of both batteries and capacitors, hybrid energy storage systems (HESS) are developed. By diverting the transient current from the batteries to the supercapacitors, HESS may extend the battery life.

A. Renewable Energy

Today, most electricity in the globe comes from coal, oil, gas, and other non-renewable sources. Polluting gases (SO2, CO, NOX, HC, and CO2) are produced when fossil fuels are burned. Climate change and global warming are the most noticeable consequences of using fossil fuels.

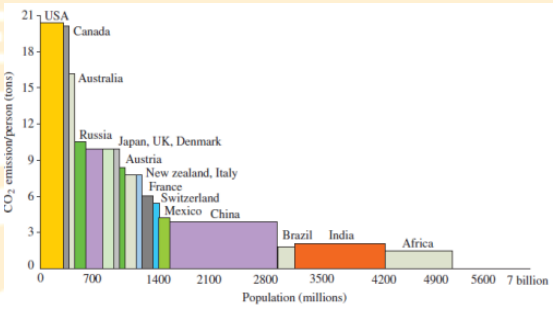

Figure 1: Per capita CO2 emissions versus the population of selected countries

An estimated 80% of CO2 in the atmosphere comes from the combustion of fossil fuels for energy, with half of that coming from the creation of electricity. The population of each country is shown along the horizontal axis, while CO2 emissions per person are shown in tonnes per year along the vertical axis in Fig. 1. The United States and Canada are

competing against one another for maximum per capita emission in the world. Following the United States, we find Australia, European countries, Russia, and Japan, all of which normally emits less than half as much as the United States. The global warming issue is significantly impacted by a country's overall emission, which is represented by the rectangle area. The global price of these non-renewable energy is rising as well.[1]

Using renewable energy sources has become more common on the grid in recent years. A rise is anticipated for the near future.

B. Maximum power point tracking (MPPT)

Maximum power point tracking (MPPT) is increasingly common in grid-connected PV power systems and is growing in popularity in stand-alone ones. Sun trackers, which rotate and/or tilt PV modules to face the sun, should not be mistaken for this product. When a PV module or array operates under different operating circumstances, MPPT enhances the power output from the module or array and thereby improves system efficiency. MPPT consists of a controller and a switch-mode DC-DC converter. MPPT may be replaced with a switch-mode inverter in grid-tied installations. A DC-DC converter performs the MPPT function when used alone. [2]

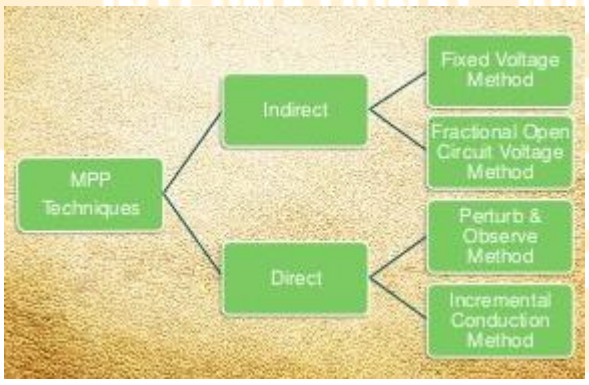

Fig. 2. Different MPPT techniques

II. LITERATURE REVIEW

(Shahgholian, 2021) [1] A microgrid is an important and necessary component of smart grid development. It is a small-scale power system with distributed energy resources. To realize the distributed generation potential, adopting a system where the associated loads and generation are considered as a subsystem or a microgrid is essential. In this article, a literature review is made on microgrid technology. The studies run on microgrids are classified in the two topics of feasibility and economic studies and control and optimization. The applications and types of a microgrid are introduced first, and next, the objective of microgrid control is explained. Microgrid control is of the coordinated control and local control categories. The small signal stability and methods in improving it are discussed. The load frequency control in microgrids is assessed.

(Ansari, 2019) [2] Renewable energy is plentiful, and technologies are improving all the time. There are many ways to use renewable energy. We have realized that our fossil and atomic fuels will not last forever, and that their use contributes to environmental pollution. Renewable energy – which basically comes from the sun in one way or another – provides opportunities for an unlimited, sustainable energy supply with low environmental impact. Most of the power generation in India is carried out by conventional energy sources, coal and mineral oil-based power plants which contribute heavily to greenhouse gases emission.

(Tetuko, 2021)[3] A solar power plant or photovoltaic (PV) is a generator that converts energy from light into pollution-free electrical energy. However, changes in the intensity of solar radiation and ambient temperature Photovoltaic (PV) which are not linear are the main problems of PV system's inefficient energy conversion that occurs. Control using the Maximum Power Point Tracker (MPPT) method based on the Perturb and Observe (P&O) algorithm which is applied to overcome these problems. Maximum Power Point Tracker (MPPT) itself is a technique for tracking the maximum output power point of the PV system. MPPT will change the working point so that the converter will force the work of the solar panels according to their ability to always reach the maximum power point. MPPT is not a mechanical system that makes the solar panel system move according to the direction of the sun's intensity, but an electronic system that works to optimize the power output from the solar panel.

(K. S. Patel & Makwana, 2020) [4] This paper presents the modified grid side converter control (GSC) technique which enables the GSC to work as a shunt active filter to mitigate the grid current harmonics produced by the nonlinear load, as well as to transfer power from the grid to the rotor of doubly fed induction generator (DFIG) or vice versa. The main contribution of this proposed technique is an addition of a shunt active filter with space vector pulse width modulation (SVPWM) controller in GSC control itself in order to achieve a better grid current %THD profile, and simultaneously to control active power for variable wind speed. The reactive power supply to the DFIG and extraction of maximum power is achieved using RSC. The comparison of the modified GSC control technique using hysteresis current control (HCC), and SVPWM controller used to mitigate the harmonics is presented with different wind speeds.

(Ali, 2020) [5] In this paper, a Renewable Energy system, Hybrid type using wind and Solar Energy system is proposed. Here two back-to-back converters using IGBT are interfaced with Permanent Magnet Synchronous Generator (PMSG) and Photo Voltaic Systems (PV) connected to linear load. A capacitor is connected between the Back-to-Back converters to maintain a steady voltage and to reduce the ripples. A Battery Energy storage system (BESS) is connected between the back-to-back converters. Battery Energy storage system gets charged when wind and PV energy is sufficient to the load and it Supplies when required by the load. Maximum Power point Tracking (MPPT) technique is implemented as a control mechanism for wind and PV systems to maintain unity power factor at the PMSG by controlling the generator side converter .and to improve the power quality. MATLAB/SIMULINK software is used to simulate the results to verify the impact of control strategies on the system for variable wind speeds and variable irradiance.

(MUSSA, 2019) [6] This paper demonstrates the design of a working prototype of 5-12V DC-DC Boost Converter. The boost converter circuit is designed using MOSFET, Resistor, Capacitor, Inductor and Diode. The key principle that drives the boost converter is the tendency of an inductor to resist changes in current. Inductor is designed using ferrite pot core and windings. This paper briefly reviews the technology used in switched mode power supplies for DC to DC conversion for transferring energy from input to output.

(Dalla Vecchia et al., 2019) [7] This paper introduces a new family of non-isolated dc-dc converters that are generated by the integration of the active switched-capacitor (ASCC) and the conventional commutation cell (CCC). Based on the commutation cell concept, the new conceived hybrid active commutation cell (HACC) provides three different types of hybrid converters: buck, boost and buck-boost. All three converters are investigated in this study through the following approaches: topological stages, static gain analysis considering the switched - capacitor features, generalization of the HACC and gain for Mcells and steady-state analysis. The buck version presents a high conversion rate, which demonstrates that it has potential for step-down applications. To verify the proposed topologies, a prototype was built with the following specifications: 600 V input voltage, 150 V output voltages, 70 kHz switching frequency and 1 kW rated power.

(Dida, 2019) [8] This paper proposes a variable speed control algorithm for a grid connected doubly-fed induction generator (DFIG) system. The main objective is to track the maximum power point by using an adaptive perturbation and observation (P&O) technique based on fuzzy logic controller (FLC), and compares it with the conventional optimal torque (OT) control method for large inertia wind turbines. The role of the FLC is to adapt the step-size of the P&O method according to the operating point. The control system has two control systems for the rotor side and the grid side converters (RSC, GSC). Active and reactive power control of the back-to-back converters has been achieved indirectly by controlling q-axis and d-axis current components. The main function of the RSC controllers is to track the maximum power through controlling the rotational speed of the wind turbine. The GSC controls the DC-link voltage, and guarantees unity power factor between the GSC and the grid regardless of the magnitude and direction of the slip power. The proposed system is developed and tested in

MATLAB/ SimPowerSystems (SPS) environment.

(Muhtadi et al., 2018) [9] Due to sheer dependency upon fossil fuel sources, Bangladesh as a country is not free from numerous negative aspects. The country's requirement for a certain portion of power be generated from renewable energy sources is due and required renewable energy target (RET) needs to be fulfilled. In this study, potential of distinguished coastal sites for entirely renewable energy such as solar and wind sources based microgrids for chosen community is explored. Microgrid architecture is appropriate considering the coastal areas' geographical locations and the inconvenience in grid extension. Study suggests, potential of coastal sites are found to be feasible for such structures based on real case scenario data and modeled technical scheme.

III. CONCLUSION

Wind and solar energy system grid integration and power quality concerns and literature-based solutions are discussed. Grid-integrated solar and wind power systems, in particular, are analysed for their causes, effects, mitigation solutions, and topologies, with the benefits of these systems emphasised.

Power electronics devices are a feasible alternative for mitigating variations and intermittent issues. Furthermore, energy storage, dump load, and maximum power point tracking (MPPT) might all be employed to mitigate PV systems' inherent vulnerability to power fluctuations. In addition to the aforementioned, the integration of novel materials and storage components into the balance of systems may help minimize the difficulties of grid integration.

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