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Original Article

Implementation of PV-Wind based Microgrid System using Whale Optimization Algorithm

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Abstract - Recently, Micro Grids (MGs) have become extremely popular due to their advantages of effective power conversion and high transmission efficiency. The MG and Nonlinear Loads (NL) are being incorporated into the electricity network. MGs are connected by Voltage Source Converters (VSCs), and NL infuses harmonics into the utility grid using power devices. However, the emergence of stability problems in the MG is caused by the nonlinear characteristics of Renewable Energy Sources (RESs), the rising use of power electronic devices and unexpected variations in load. This paper aims to suggest a microgrid that employs RESs comprising wind and Photovoltaic (PV) systems. This method is established to distribute stable power to loads without any interruptions. A Doubly Fed Induction Generator (DFIG) is deployed as a wind system. To stabilize the PV input voltage, the Boost converter is implemented. Furthermore, intended for enhancing the microgrid's performance, a constant output without distortion is attained from the converter with the deployment of a Whale Optimized Proportional Integral (WO-PI) controller. The 3ϕ inverter is utilized to sustain the DC link voltage, and it combines PV, wind, and battery output at a single point and feeds it to the grid. The results are implemented using the MATLAB platform, and simulation outcomes show that the suggested control technique is effective with a THD of 2.33% and reduced overshoot issues.

Keywords - PV system, Wind system, Boost converter, WO-PI controller, MG, DFIG.

1. Introduction

RESs have recently taken substantial importance as a consequence of the increasing need for electricity. Using innovative, clean energy sources has become essential due to the demand for fossil fuels for power generation [1-3]. As a result, the construction of clean energy using wind and PV input power is projected to be a feasible option in the future. Solar and wind energies are affordable to use and produce no emissions. Also, it brings electricity to isolated locations not handled by electricity companies or connected to the grid. Furthermore, it can provide a remedy for nations experiencing a shortage of fossil fuel energy [4, 5].

Unfortunately, the accessibility of these sources is intermittent and weather-dependent. The power system has challenges while using these resources because of the unpredictable nature of power output and its variations [6]. The utility grid's stability and standalone applications ultimately depend on incorporating clean energy sources [7]. So, adopting Energy Storage Systems (ESS) offers a fantastic remedy for the intermittent issue. Consequently, hybrid energy systems incorporating ESS are highly suggested to ensure an effective and smooth power transfer. Hence, MGs are a crucial paradigm to combine alongside ESS with distributed and renewable energy sources [9-11].

In the modern world, dealing with the growth of clean energy requires the development of the MG model. It has the potential to enable the final user to store, regulate, produce, and maintain a portion of the energy consumed, turning the client into a contributor to the network instead of a consumer [13]. MG offers numerous benefits to customers and utilities like each other. Reduced power flow on transmission and distribution lines, reduced power losses and lower costs[21,25] for excess energy sources are all benefits of the MG approach. MG can also minimize the load demand on the electrical grid and contributes to lowering pollutants that represent a concern from climate change. Also, it can help in fixing network issues [14].