

Power Quality Improvements in Wind Diesel Power Generation System

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Abstract— Generation of electricity using diesel is costly for small remote isolated communities. At remote location electricity generation from renewable energy such as wind can help reduce the overall operating costs by reducing the fuel costs. However, the penetration of wind power into small diesel-based grids is limited because of its effect on power quality and reliability. This paper focuses on the combination of Wind Turbine and Diesel Generator systems for sustained power generation to improve the power quality of wind generation system. The performance of the optimal control structure are assessed and discussed by means of a set of simulations.

Keywords- Triple – renewable energy, wind diesel system, a synchronous generator, asynchronous generator, diesel generators, micro grid;

I. INTRODUCTION

Global warming is one of the most serious environmental problems facing the world community today. Scientists are highly interested in solving it. It is characterized by the increase in the average temperature of the earth and extreme weather conditions¹. On top of that, the rapid depletion of fossil fuels worldwide has necessitated an urgent search for another alternative energy sources to meet the current human requirements. Wind power is one of the renewable energy sources that scientists have recently drawn attention to². Being an abundantly available and non-polluting energy, it can make a wonderful alternative source of power. Moreover, this clean alternative source of energy can fit attractively for many uses and applications. On the hand, only 6.4% of total renewable energy sources available in the world are in use today. To get more consistent flow of energy to the user request, there has been a growing trend to combine renewable energy sources with diesel generators, giving a hybrid power generation system⁴. They are activated to serve as an electrical energy source in telecommunication systems or clinics in border crossings, remote areas, deserts and isolated habitats. These locations need systems which are generally independent from large interconnected networks⁵. In literature thousands of researches have been done to find a way that hybrid systems could be continually utilized in an isolated area or be connected to a power grid. In⁶ a study a hybrid autonomous system was introduced and presented as⁷ a power system in an island in Bangladesh. Several parameters are entered in the study as well as in the system design, but in books it

is difficult to find how to measure the various components of an autonomous system. Most of the books focus on the basic technological theory of the device, not the measurements of equipment. Variable parameters of most of renewable energy sources often take a complex control system⁸. However, the design of the right voltage and frequency used to control a wind-diesel system is shown in⁹. In¹⁰ P. S. Panickar et al study a strategy of adaptive control by a variable wind speed for an application for a wind-diesel hybrid system. Modeling is also a major factor in studies developed to simulate a functioning system. Much software allows us to do that. There is an example of modeling and simulating various hybrid systems presented with MATLAB-Simulink software in^{11,12}. In¹³ a model of a hybrid power generation is made by the HOMER software. To improve the quality of the energy produced by a system of wind energy production, a wind-diesel hybrid system is proposed in this study. Simulation results in Matlab \ Simulink are presented to confirm the proper functioning of the wind diesel hybrid system to reduce greenhouse gas emissions.

II. DIFFERENT STRUCTURES OF HYBRID SYSTEM

The configuration of the hybrid system obviously depends on the availability and use constraints of energy resources. This requires a measurement and a preliminary analysis of site conditions.

There are several structures of an autonomous wind-diesel hybrid system: wind-diesel system with short-term storage, wind-diesel system with long-term storage (Batteries, compressed air, hydrogen, etc.)¹⁴ and wind-diesel system without energy storage. The choice of a suitable structure of a hybrid system is connected to two parameters. The first is the satisfaction of the technical performance in meeting the requirements of power quality; whereas the second is the economic increase of saving fuel. Thus, the costs of electricity production in the autonomous systems will be minimized¹⁵.

III. WIND-DIESEL WITHOUT STORAGE

In our study we chose to work on the third structure of wind-diesel system without energy storage (Figure 1).