

A Study on Hybrid Power System through Wind and Diesel Generator

Vijay Yadav¹, Sharad Arya², Preeti Vijay³

Assistant Professor¹

MAIT, Kota

Corresponding Authors' Email: vijayya84@gmail.com¹, sharadarya.14@gmail.com², preeti.aaditya@gmail.com³

Abstract

In this paper an active power control strategy has been proposed such that when the wind alone is not able to meet the energy requirement, without compromising the frequency a transition occurs to wind diesel manner so that the energy need is met. Then the system's dynamic concert is compared for two cases with squirrel cage induction generator and permanent magnet induction generator. The mathematical model considered uses a STATCOM to meet the reactive power need upon sudden step change in power. The performance and the analysis is done in a easy to use MATLAB/Simulink environment.

Keywords: Hybrid Power System, STATCOM, Wind and Diesel Generator.

1.INTRODUCTION

A single renewable energy source may not be able to meet the load demands apart from the fact that continuous supply of energy may not be ensured (say wind is not available on a particular day in a wind farm). This makes the significance of hybrid energy systems such as wind-PV, wind-diesel along with use of battery etc. Owing to the fast control ability and response time of the diesel engines, they are quite popular

for integration with wind energy conversion systems (WECS). Hence a wind diesel hybrid system is considered in the paper. Induction generators are utilized for wind systems. However modern technologies have paved way for other generators such as self-excited type, permanent magnet type etc. which have their relative merits and demerits which has been explored here. A wind turbine is a device that converts kinetic energy from the wind into electrical power.

A wind turbine which is used for charging batteries may be referred to as a wind charger. A quantitative measure of the wind energy available at any location is called the Wind Power Density (WPD). It is a calculation of the mean annual power available per square meter of swept area of a turbine, and is tabulated for various heights above ground. Calculation of wind power density includes the effect of wind velocity and air density. Wind turbines are designed to exploit the wind energy that exists at a location. Aerodynamic modeling is used to find out the optimum tower height, control systems, number of blades and blade shape.

A **fuel cell** is a device that uses hydrogen as a fuel to generate electrons, protons, water and heat. Fuel cells are electrochemical devices that transfer the chemical energy of a reaction directly into electrical energy. The fuel cell must provide competitive, reliable, and quality power exclusive of emitting pollutants such as oxides of nitrogen, carbon or sulphur. It must react quickly to changes in load and have low maintenance requirements as well as a long cell life. In the graphic chart of fuel cell, gaseous fuels

are fed continuously to the anode, and an oxidant i.e., oxygen from air, is fed continuously to the cathode compartment, the electrochemical reactions happen at the electrodes to produce an electric current.

A fuel cell is individual small unit of around 1.2V. A group of units are connected in parallel and in series to get required voltage and current ratings, that group is called fuel cell stack. Current fuel cells, when operated alone have efficiencies of about 40-55%. Fuel cell technology is based upon the simple combustion reaction (1):

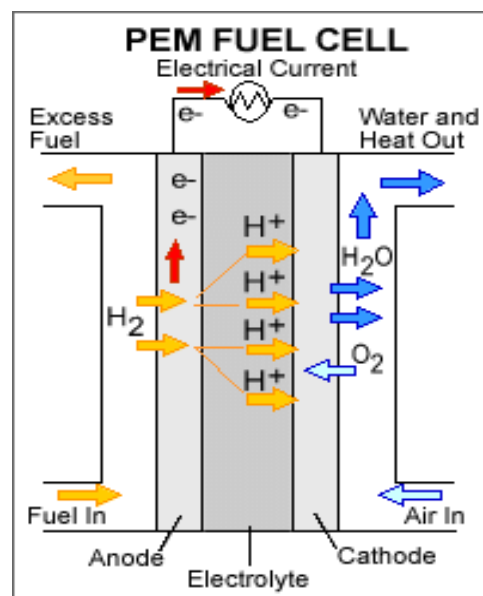
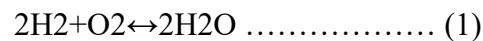


Fig 1: fuel cell

II. PROPOSED SYSTEM

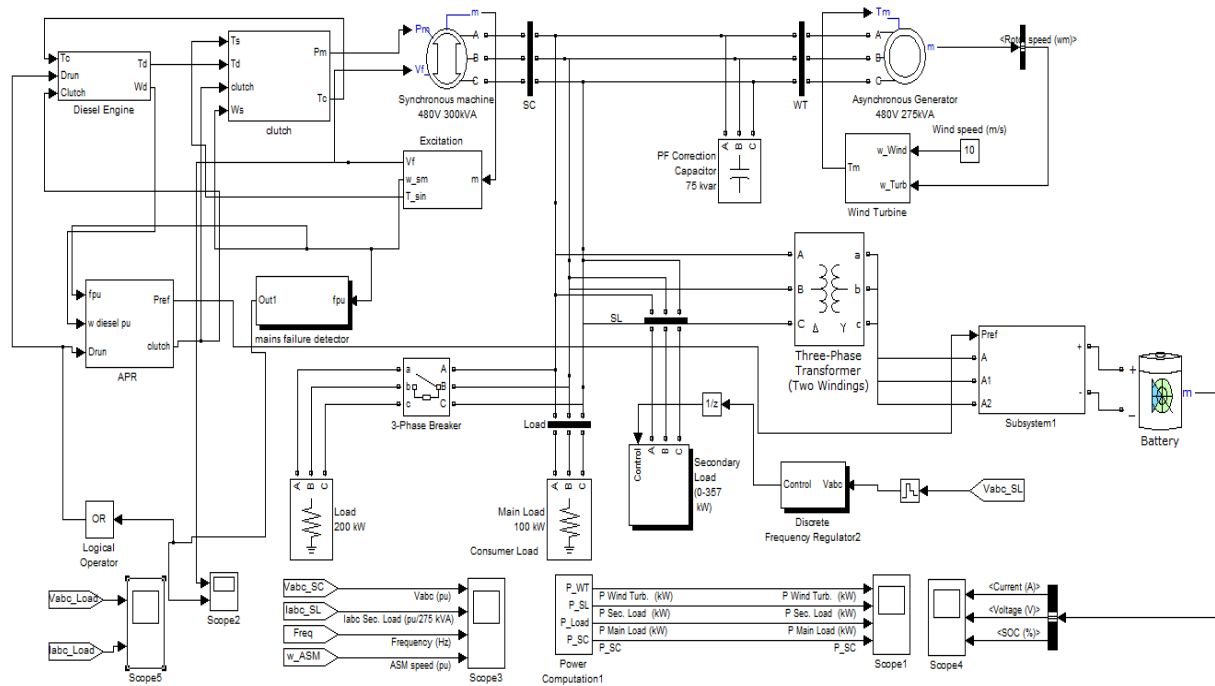


Fig 2: Simulink Schematic.

The nominal power of the WTG is 275KVA. There is no pitch control since it is stall controlled. The DL consists of eight three phase resistors which can be turned on or off by GTOs connected in series. DL's power consumption can be expressed as 8-bit binary progression. The subsystem1 connected to the battery is a current controlled inverter (CCI). It is three phase as well as bi directional in nature. The PREF signal decides its mode of operation (negative leads to discharge of battery i.e. battery supplies power and positive signal leads to charging of battery). The SM is

rated at 300KVA and the inertia constant is 1s. The clutch enables to lock or disengage the voltage regulator plus the exciter.

III. HPS SYSTEM

Hybrid systems capture is the best features of each energy resource and can provide “grid-quality” electricity, with a power range from ONE kilowatt (kW) to several kilowatts. They can be developed as latest integrated designs within small electricity distribution systems (mini-grids) and can also be retrofitted in diesel based power systems. Hybrid systems can supply a steady community-level electricity service, such as

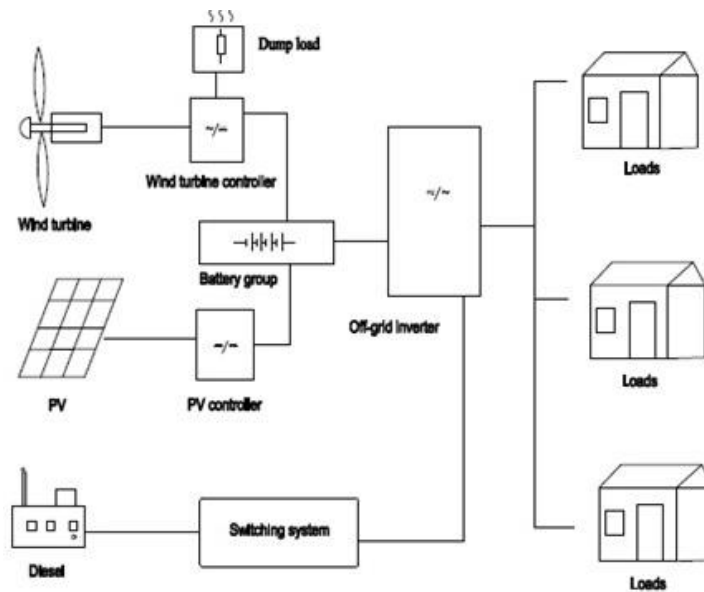


Figure 3:

village electrification, offering also the possibility to be upgraded through grid connection in the future. Furthermore, due to this fact that they have high levels of efficiency, reliability and long term performance, these systems can also be used as an efficient backup solution to the public grid in case of blackouts or weak grids, and for professional energy solutions, such as telecommunication stations or emergency rooms at hospitals.

Hybrid systems with a backup gen-set run with minimal fuel consumption because the gen-set is brought on line only to assist in periods of high loads or low renewable power availability. This results in a large

reduction in fuel consumption as compared to a gen-set only powered system.

CONCLUSIONS

The simulation results of a hybrid power system with diesel and wind power generation and a grid connected photovoltaic(PV) inverter, presented in this paper, demonstrate that the modular simulation system, developed using the matlab programming environment, constitutes a very useful tool for analysis and design of such systems. With the use this tool, a designer can easily develop control strategies to balance the system power flows under different generation/load conditions. The study of the dynamic behavior of such system, is of primary

importance for the determination of the higher penetration limits of wind turbines and PV generators, the selection of the control and protection equipment, so that acceptable performance of the system is achieved. Simulation studies, using the proposed control approach, indicate that

application of these policies may result in reduced load flowing requirements for conventional power generation units, and improve power quality and stability of the interconnected systems.

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