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Design of Continuous Mode Hybrid Standalone Power Station with Hybrid Controller to Select the Best Optimal Power Flow

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Abstract— In this paper design of continuous mode Hybrid Stand alone power station with battery and Diesel generator is modelled. The controller is designed to maximize the usage of energy sources and reduces the use of diesel generator. The state of battery charging is maintained. This paper firstly focuses on design of hybrid power station is to full fill load demand. Secondly a relay based controller is designed to select the best optimal power output as per availability of sources to minimize the use of Diesel generator and Battery operation. A supervisor control modes are further discussed for hybrid controller as per the load demand.

***Keywords*—**Diesel Generator(DG), Hybrid Controller,Supervisory control, Wind turbine Generator(WTG)

I. INTRODUCTION

. A common application of renewable energies is electricity generation. Renewable energy facilities generally require less maintenance than traditional generators, so has minimal impact on the environment. Among all the renewable energy resources, the solar and wind energies have the greatest potential as a power gene rating energy source, because of their many advantages like low or zero emission of pollutant gasses, low cost, inexhaustible sources and easy availability of these energy sources. But these systems have some disadvantages also like dependency on weather conditions. The difficulty to generate the quantities of electricity is one of the major disadvantages that are as large as those produced by traditional fossil-fuel generators. So it's necessary to reduce using the amount of energy or simply find an alternate source of energy. Using different power sources is the best solution to balance our energy problems [1]. In this paper, a continuous mode hybrid power station is proposed, modelled and studied in Matlab/Simulink. Since the controlling of voltage and frequency are one of the most important cases; therefore, control schemes are designed in order to it, within changes of loads and whether [2].Under the current global trend toward market liberalization, an overall approach for operation and control of power units is of paramount importance for the survival of any electric utility [1]. When properly applied, plant-wide instrumentation and control systems can increase plant operating efficiency, operability and manoeuvrability, robustness and reliability, as well as plant availability, thus contributing to keep down fuel, operation, and maintenance costs, which account for most of the expenses in a power plant [2]. Therefore, there is urgency to develop effective plant-wide automation systems, and consequently the associated overall unit control systems and strategies, to keep them running profitably. Also, it should be noted that the intensive use of computer based instrumentation and control systems, with everyday more reliable and powerful general purpose information processing digital devices, allows system designers to focus more on the implementation of software applications to respond to the above mentioned challenges. Since software complexity, and the costs of its development and maintenance, could easily surpass those of the hardware in which it runs, great effort and care should be paid in the design and development of general and comprehensive software systems to ease the incorporation of advanced operation (i.e., protection, control, and automation strategies) applications to enhance the performance of the power units [4]. The advantage of hybrid power systems is the combination of the continuously available diesel power and locally available, pollution-free wind energy. With the hybrid power system, annual diesel fuel consumption can be reduced and pollution can be minimized at the same time. [5] [6] .To takes full advantage of the wind energy when it is available and to minimize diesel fuel consumption, a proper control strategy must be developed. The control system is subject to the specific constraints of a particular application [5] [6]. It has to maintain power quality, measured by the quality of electrical performance, meaning that both the voltage and the frequency must be controlled. Because of this, a simulation study of each new system is needed to confirm that a control strategy results in desired system performance. The simulation study can help in the development of control strategies to balance the system power flows under different generation/load conditions. Using the typical modules provided, it is easy to set up a particular system configuration.

II. PRPOSED SYSTEM

The proposed system consists of hybrid power station consisting of renewable energy sources as a fuel. A diesel generator is also used in the combination to achieve continuous mode power supply in case of failure of renewable energy sources. The supervisory inputs are the measure of current and voltage of the system. The supervisor outputs are the signals to activate or deactivate any renewable energy sources as per the load. The total power output of the continuous mode hybrid power station is given as $P = Ps + Pw + Pd$.

Where,

Ps = Power output of solar PV system in KW, Pw = Power output of wind turbine generator in KW, Pd = Power output of diesel generator in KW.

Table-01, Electrical Specifications

S/No.	Terms	Power Ratings
1.	Wind Turbine	15KW
2.	PV	24KW
3.	Diesel Generator	50KW, 55.5KVA
4.	Battery	151kwh

III. ALGORITHM FOR OPTIMAL POWER FLOW MANAGEMENT

Here, P is total power, Ps, Pw and Pd is power generated by solar PV, wind turbine (WT) and diesel generator (DG) respectively. AL1 and AL2 are two additional resistive load banks along with the main load.

The frequency regulation is developed with a set of resistive dump loads. Total 8 sets of resistive dump load are used to regulate the frequency in case of over generation of electrical power and each set of dump load consumes 0.5kW power. Maximum power consumed by dump loads in this system is 4kW. First bank of 0.5kW dump load is turned on in case of extra power in the system. If the system requires rest banks are added in operation to regulate the frequency. The controller for frequency regulation is developed with a standard three phase locked loop (PLL) control strategy. It allows the system to operate at a constant frequency and synchronize the operation with multiple sources.

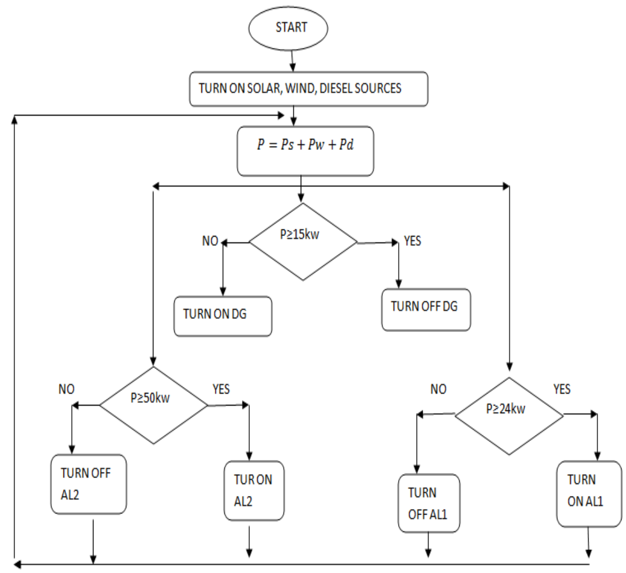

Figure-01, Algorithm for Optimal Power Flow Management

IV. OPERATION OF CONTROLLER

The controller will operate as per load demand and availability of energy sources. The operation of the multiport controller is under different modes.The operating modes are shown in Table 02.

Table-02, Operating Modes

Solar	**Wind**	**Diesel**	**Total Power**	**Modes**	**Operating time in sec**	**Load**
ON	0N	OFF	15KW	P1	0-2 sec	Main load
ON	ON	OFF	24KW	P2	2-10sec	ADL1
OFF	ON	ON	50KW	P3	10-15 sec	ADL2
ON	ON	ON	89KW	P4	15sec	ADL2

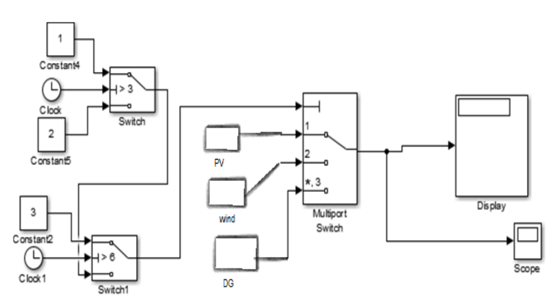

Figure-02, Relay Based Multiport Controller for Hybrid Power Station

V. RESULTS AND DISCUSSION

Fig 3 shows the output voltage generated by solar, wind and diesel generator. The average power generated by solar PV is approximately 24 kW. Wind energy generates up to 15kW depending on load demand. Diesel engine is switched off when total generated power reaches 15kW. The load power in kW is consumed by resistive main load, additional load and dump load .The breaker for first additional load bank is closed when both solar PV and wind energy conversion system is in operation and empowering 15kW main load. Another breaker for second additional load is closed when total power generation reaches 24kW.In order to regulate the frequency, all dump loads are being added along with additional loads between 0.5s to 1s. The frequency regulator turns them off gradually when the frequency is stable at 60Hz after 1s.Some fluctuation in load voltage is noticed between the period up to 0.2s when both solar and wind energy are added in operation. The system frequency is being affected during the same period due to same operation.

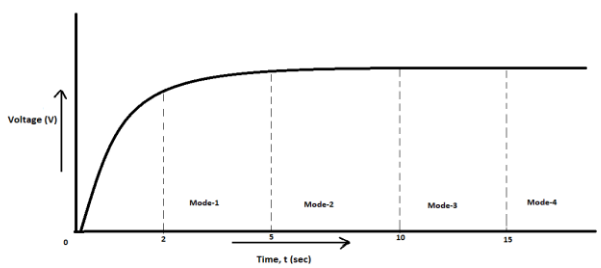

Figure -03, Output of Continuous Mode Hybrid Power Station after Controller Operation

VI. CONCLUSION

This study presents a detail model of continuous mode hybrid power generation. The simulation is done to study the behaviour of PV, Wind and Diesel. A simple multiport operation based controller is designed for the power management strategies to analyze the reliability of system. To regulate the fluctuating frequency dump load is applied. In continuation of this work the output of this continuous mode hybrid power supply system is now fed as source for inverter and multilevel inverter and power quality issues for both will be analyses for rural area electrification purposes.

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