Optimal Design of Hybrid Renewable Energy System (HRES) For Off Grid Applications in Remote Areas

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ABSTRACT

Renewable energy sources are omnipresent, easily available, and environmentally friendly. This is very useful in distant and remote area locations, so that it is becoming very popular and can be used for rural electrification of remote areas. Rural electrification is the process of bringing electrical power to rural and remote areas. A hybrid renewable energy system((HRES), also known as remote area power supply (RAPS), is an off-the-grid electricity system for locations that are not covered with an electricity distribution systemTypical HRES include one or more methods of electricity generation, energy storage, and regulation. Electricity is used not only for lighting and household purposes, but it also allows for mechanization of many farming operations, such as threshing, milking, and hoisting grain for storage.In this section MATLAB simulation is performed for optimal design of hybrid renewable energy system (HRES) for off grid applications in remote areas where transmission of power is difficult.

Key words-

1. INTRODUCTION

Many problems are brought about by conventional energy sources such as insecurity of oil supply, excessive pollution, and the risk of climate change due to fuel fires. Therefore, the search for alternative energy sources has become a matter of urgency. One of the most common alternative energy sources are solar power plants that convert solar energy or solar heat into electricity. However, the downside is that it does not work when it is cloudy or rainy. In many countries the peak operating times of wind and solar systems occur at different times of the day and year, therefore, mixed systems have more opportunities to produce energy when needed. This has created the need to combine solar energy with wind power in order to obtain a solid energy source known as the hybrid solar wind power generation system (Zhou et al., 2010). A common use of renewable energy to generate electricity. Renewable power stations generally require less repair than conventional generators, so they have less impact on the environment. Among all renewable energy sources, solar and wind power are the main source of energy for measuring energy production, due to its many benefits such as low or zero emissions, low costs, combustible resources and easy access to these energy sources. . But these systems have some problems such as climate dependence. Difficulty in generating electricity ratings is one of the biggest disadvantages such as those generated by generators that generate fuel. It is therefore necessary to reduce energy consumption or simply find another source of energy. Using different energy sources is the best solution for balancing our energy problems (Pachoril et al., 2014). The hybrid system that combines wind, solar, and diesel power generation system has become popular because of its advantages over either single system. The main advantages of hybrid systems are fuel saving lower atmospheric contamination, savings in maintenance, silent systems, and connection to other power supplies which enable higher service quality than traditional single-source generation systems.

1.1 HYBRID HRES SYSTEM FOR RURAL ELECTRIFICATION

The HRES system can supply electricity outside the local area network. The HRES system allows homes, farms or dormitories, whether remote or urban, to generate their own electricity. The HRES systems shown in Figure 1.1 are generally based on renewable energy source and / or diesel generating set.

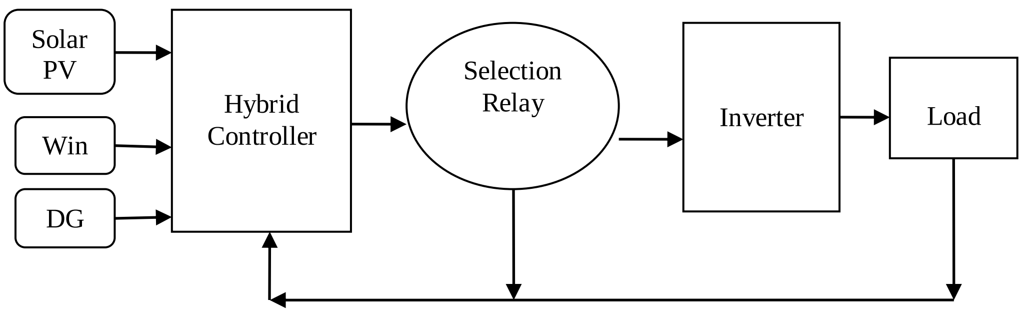

Figure-1.1: Functional Block Diagram of HRES system

The HRES system can be used to avoid the cost of electrical connections or individuals wishing to be independent of the main electrical network or ‘grid’. Many citizens use HRES programs. Not currently connected to the local distribution network, or need to be disconnected. The type of installed system depends on your specific energy needs and renewable energy resources available locally. There are many different ways to configure the SAPS system - solar, wind, hydro or diesel engine sets; can provide independent electrical services. Renewable energy sources are ubiquitous, readily available, and environmentally friendly. This is very useful in remote and remote areas, to make it more popular and used to install electricity in rural areas in remote areas. Rural electrification is a program to bring electricity to rural and remote areas. Electricity is not only used for lighting and domestic purposes, but also allows for the production of machinery in many agricultural activities, such as threshing, milking, and raising grain for storage.

2. MATHEMATICAL MODELING OF HYBRID HRES SYSTEM

The proposed system consists of a hybrid power station that combines renewable energy sources as fuel. The diesel generator is also used in combination to achieve continuous power supply in the event of failure of renewable energy sources. The directional input is the current measurement and voltage of the system. The output of the controller is the signal to turn on or off any renewable energy sources according to each load. The total output power of a continuous mixed power channel is provided as

$$P = Ps + Pw + Pd$$

Where,

Ps = Power production of solar PV scheme in KW,

Pw = control production of wind turbine producer in KW,

Pd = Power production of diesel producer in KW.

Here, P is the absolute power; Ps, Pw and Pd are the power produced by solar PV, wind turbine (WT) and diesel generator (DG) respectively. AL1 and AL2 are two additional resistant banks and a heavy load. Frequency regulation is developed with a set of opposing dumping loads. A total of 8 waste disposal sets are used to control the frequency in the event of overpowering power output and each set of dump load consumes 0.5kW of power. The maximum power used for disposal of loads in this system is 4kW. The first 0.5kW dumping bank is opened in the event of additional power in the system. If the system required rest banks were added to the operation to control the frequency. The frequency control is developed with a closed phase control (PLL) control strategy. It allows the system to run on a regular basis and syncs with multiple source.

The mathematical modeling of standalone power supply system is shown in figure 1.2. The whole system is analyzed through simulation in MATLAB. The hybrid SAPS system includes solar photo voltaic system modeling, wind turbine generator modeling and diesel generator modeling. The main purpose of a mixed power station is to meet the demand for electricity while simultaneously increasing the use of renewable energy sources while improving battery and diesel generator performance. The supervisory control determines the operating modes of each generator unit separately for optimized operation. Fundamentally these operating modes are determined by energy balance between the total demand and total generation. To design the supervisory control wind and solar are considered as a main energy source and the complementary energy sources are in charge of battery and diesel generator.

Table-1.1: Electrical Specifications of SAPS

S/No.	**Terms**	**authority Ratings**
1.	wind speed Turbine	15KW,230V $_{A.C.}$
2.	PV	24KW, 24 V $_{D.C.}$
3.	Diesel producer	50KW, 24 V $_{D.C.}$
4.	Converter Duty sequence	T_{ON} is 30% of T

2.1 OPERATION OF CONTROLLER

The controller will operate according to the need for each load and the availability of energy sources. The main purpose of the controller is to maintain continuous power supply and to increase solar and wind power consumption. Inverter input continuous voltage level and continuous power are required. In a case one generating unit is switched OFF other will be activated. The different selection modes are given in table 1.2.

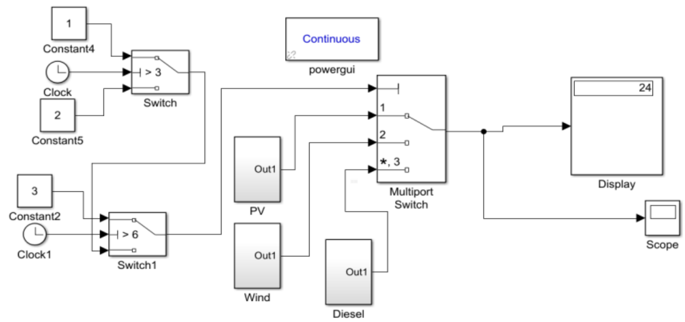

Figure-1.2: communicate Based Multiport organizer for Hybrid authority position

Table – 1.2: collection mode of SAPS

astral	storm	Diesel	whole authority	mode
ON	ON	OFF	15KW	P1
ON	ON	OFF	24KW	P2
ON	ON	ON	50KW	P3
ON	ON	ON	89KW	P4

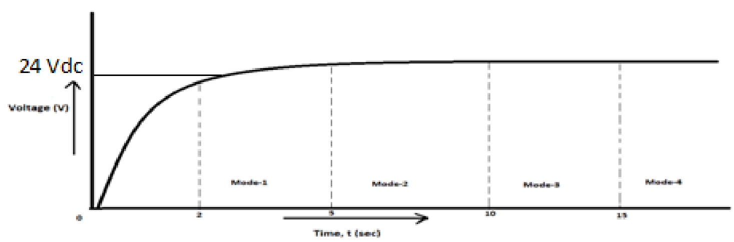

Figure - 1.3: preferred Output of nonstop Mode Hybrid Power position after organizer process

Figure 1.3 shows the energy required to generate solar, wind and diesel power. The standard power generated by solar PV is approximately 24 kW. Wind power produces up to 15kW depending on the load requirement. The diesel engine is turned off when the total power output reaches 15kW. Load capacity in kW is used for core resistance, overload and dump load .The additional load bank interrupt is closed when both the solar power conversion system operates and enables a maximum load of 15kW. Another shortcut for the second additional load is closed when the total power output is up to 24kW. To control frequency, all dump loads are added along with additional loads. This study provides a detailed data model for continuous power generation. Simulation is done to learn the behavior of PV, Air and Diesel. Multi-port performance controls are designed with power management strategies to analyze system reliability. Controlling variable load dynamics used. In the course of this work the output effect of this continuous mixed power supply system is now provided as a source of inverter and multilevel inverter and the harmonics analysis in both will be analyzed for the purposes of electrification in rural areas. Also a hybrid energy storage system is designed using a batter and an ultra capacitor to improve the final capacity during the availability of renewable energy sources.

3. RESULTS

The load analysis of the SAPS system when directly connected to load is performed and results are obtained through simulation of figure 1.4 in MATLAB. Figure 1.5 represents the power generate by solar PV, storm and diesel producer. The standard control generate by PV is approximately 6KW and wind generates up to 10 KW. Diesel generator is switched off total power generated reaches 5KW.The first additional load (AL_1) is closed when PV and wind system is operating and empower 10KW major weight. next extra load (AL_2) is stopped up what time total power reach 12.5 KW. Frequency control of this continuous mixed power station is enhanced by a set of dissipation disposal. A total of 8 waste disposal sets are used to control the frequency in the event of overpowering power output and each set of dump load consumes 0.5kW of power. The maximum power used for disposal of loads in this system is 4kW. The first 0.5kW dumping bank is opened in the event of additional power in the system. If the system required rest banks were added to the operation to control the frequency. The frequency control is developed with a standard single phase locked loop (PLL) strategy. It allows the system to run on a regular basis and syncs with multiple sources. Figure 1.7 shows the control of the electric field on the load side and the frequency of the system.

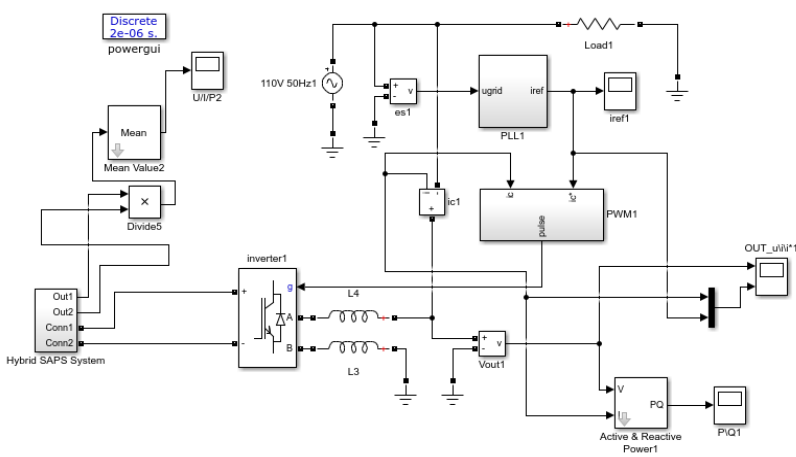

Figure-1.4: Simulation Analysis of HRES system by Integrating Solar PV, Wind and Diesel Generator in Single Unit

Other fluctuations in load capacity are observed between the period of 0.6s to 0.8s when both solar and wind energy are added to the operation. The frequency of the system is affected at the same time due to the same performance. The load capacity in kW is used for the main non-resistance load, the additional load and the load load dump load in Figure 1.5. To control frequency, all dump loads are added along with additional loads between 0.8s to 1.5s. The frequency control shuts off gradually when the frequency is stable at 50Hz after 1.5s.

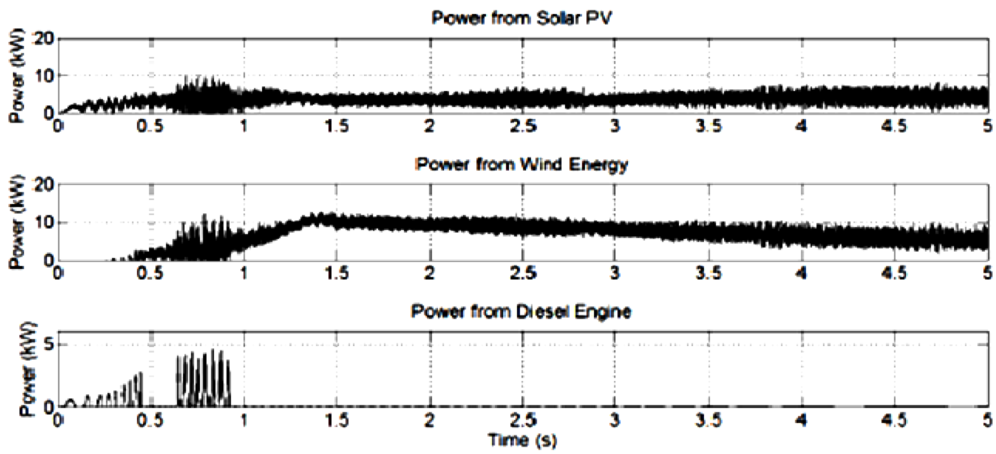

Figure-1.5: Power output of solar, wind and diesel generator

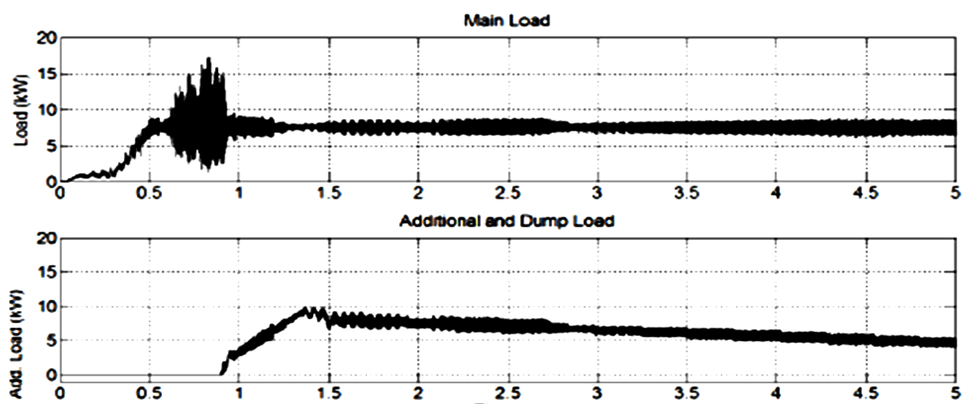

Figure-1.6: Main Load and additional dump load profile

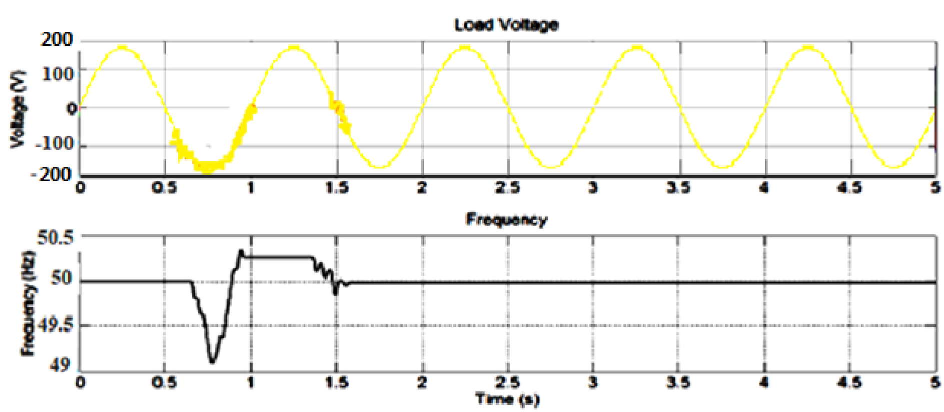

Figure-1.7: Regulation of voltage and frequency at load side

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