A Simulation Model For Hybrid Power System Sources

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Abstract- *The project is to investigate architecture of automatic power system sources to achieve a good performance of the individual sub models for the system and to choose the cheapest source that can supply the load demand at minimum cost and maximum availability while preserving the reliability of the system. This project uses different energy sources photovoltaic (PV), wind turbine based permanent magnet synchronous generator(PMSG), diesel generator, battery and grid which are connected together for providing power generation and to supply the electrical load.*

Keywords- Grid connected hybrid power system, Simulation of HPSS, Solar-wind-diesel and battery modelling in Simulink

I. INTRODUCTION

Hybrid renewable energy systems (HRES) are becoming popular in power systems for providing electricity in remote areas. A hybrid energy source consists of more than one renewable energy system which is applied with each other to excess power system efficiency as well as greater balance in energy supply.

The integration of two or more energy sources is known as hybrid power system. The fundamental point of preference hybrid energy system is the improvement of unwavering quality of the hybrid power system and money saving advantage of the system. Hybrid energy system provides a high level of energy safety through the mix of generation techniques and easily combine a power storage system. Renewable energy sources such as solar and wind are omnipresent and environmental friendly.

A two in one system for green power generation; a photovoltaic sub-system for the times when the wind isn't blowing at a slow speed, and a wind powered sub-system for nighttime and periods without sunlight.

Now a days world energy demands are increasing, but fossil fuels are depleting. This leads to increase interest on alternative sources like solar energy, tidal energy, geothermal energy, wind energy.

Today solar and wind energy are most significant because these are eco-friendly. If we use these two sources at a time we get more power to reach our energy demands. The system which is used both sources is Hybrid Solar-Wind Power Generation System. Hybrid solar-wind powered systems only become a cost-competitive option in areas where wind and solar patterns supplement each other significantly; otherwise they will be too pricey. Also do not forget that energy efficiency comes first. In other words: if you want to install a hybrid system to meet your home's electricity needs, consider insulating your home to high levels and install high-performance windows, appliances and lighting, zin order to reduce the electricity consumption to the lowest extent possible. Only then a hybrid wind-solar system can make sense. Otherwise you'll need a very large and expensive system.

II. BLOCK DIAGRAM

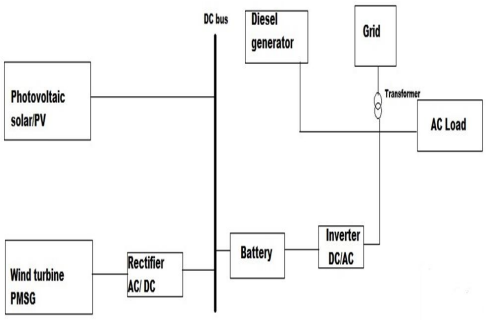

Figure 1.

The above block diagram consists of the configuration renewable energy (photovoltaic–wind turbine)–battery–diesel-connected with the grid as power generation and auto controller, converter (inverter, rectifier) with additional/auxiliary components which is helpful for full time functioning of the hybrid system. The performance of the systems can be predicted, firstly individual components should be modeled and then their combination can be evaluated to meet the demand reliability. If the power output prediction

from these individual components is accurate enough, the resultant combination will deliver power at the least cost.

The hybrid power system sources are modeled and simulated in Matlab and Simulink. The proposed hybrid power generation system to produce electricity and supply the load with considering and studying three cases of loads. The system consists of the photovoltaic (PV) with the wind turbine based permanent magnet synchronous generator (PMSG), the battery. Moreover the system contain the diesel generator and grid to meet the load demand in case of the power sources of (solar and wind) are not sufficient to the load demand. For case study a solar PV module of 90Kw along with a wind power system of 10Kw is modeled in Simulink.

Solar and wind power have the highest priority as they are cheapest power sources. If the load is more than the capacity of solar and wind then rest of the demand is meet by grid supply. In case if grid is not available diesel generator as a backup power system, it begins to work as emergency power-supply to feed the load demand in this case, diesel works and satisfies the deficit power.

III. HYBRID SYSTEMS MODELLING

1. SOLAR PV SYSTEM

A photovoltaic system, also PV system or solar power system is a power system designed to supply usable solar power by means of photovoltaic. It consists of an arrangement of several components, including solar panels to absorb and convert sunlight into electricity.

A solar inverter to change the electric current from DC to AC, as well as mounting, cabling and other electrical accessories to set up a working system. It may also use a solar tracking system to improve the system's overall performance and include an integrated battery solution, as prices for storage devices are expected to decline

Figure 2. Photo voltaic system

Solar PV System Design:

The first step designing a solar PV system is to find out the total power and energy consumption of all loads that need to be supplied by the solar PV system. Add the watt hours needed for all appliances together to get the total watt hours per day which must be delivered to the appliances.

Different size of PV module will produce different amount of power. To find the sizing of PV module, the total peak watt produced needed. Divide the total watt hours per day needed from the PV modules to get the total watt peak rating needed to operate the appliances.

An inverter is used in the system where AC power output is needed. The input rating of the inverter should never be lower than the total watt of appliances.

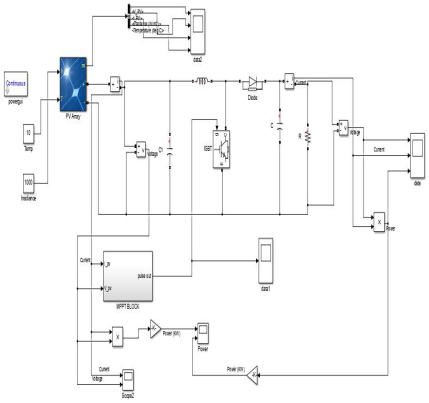

Figure 3. Modelling of solar pv system

2. WIND TURBINE

A wind turbine is a device that converts the wind's kinetic energy into electrical energy.Wind is the movement of air mass and it has kinetic energy. The kinetic energy of the wind can be converted into mechanical energy using a wind turbine with rotor blades. Then through using a generator the mechanical energy is converted to electrical energy.

The smallest turbines are used for applications such as battery charging for auxiliary power for boats or caravans or to power traffic warning signs. Slightly larger turbines can be used for making contributions to a domestic power supply while selling unused power back to the utility supplier via the electrical grid.

Figure 4. Wind turbine

Modelling of Wind Power Generation System

Wind is the movement of air mass and it has kinetic energy. This kinetic energy of the wind can be converted into mechanical energy using a wind turbine with rotor blades. Then through using a generator the mechanical energy is converted to electrical energy.

The permanent magnet synchronous generator (PMSG) is used to convert the wind power into electrical power. Comparing all the type of generators that are used in wind turbines the PMSG's have the highest advantages because of during normal operation they are more stable, secure and it provides higher efficiency in lower speed applications essentially the wind's kinetic energy in the rotor which is mechanically coupled to generators comes from wind turbine.

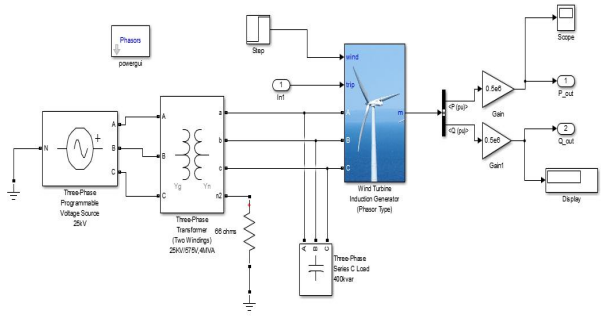

Figure 5. Modelling of Wind turbine

3. MODELLING OF BATTERY

Nickel-Metal-Hydride battery of capacity of 10,000 Ah is being used to store the power generated by renewable sources as solar PV and wind generator [14].The stored power in battery further being used to meed the load demands use of ultra-capacitor can improve the overall system efficiency and reliability. The DC power is converting into AC power through an inverter before reaching the load.

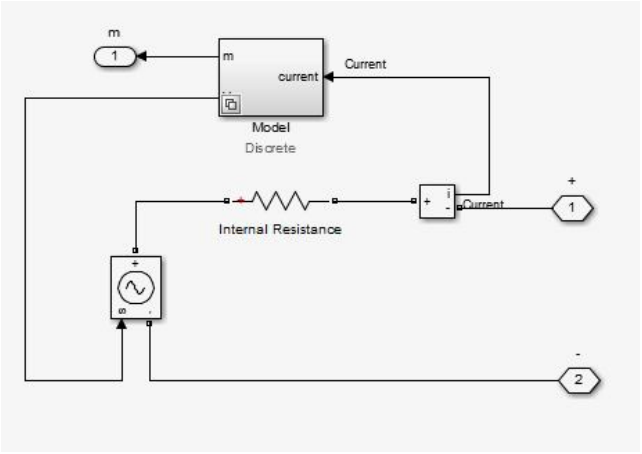

Figure 6. Modeling of battery

4. DIESEL GENERATOR

The set of diesel generator changes fuel energy (diesel or bio-diesel) into mechanical energy using of an internal burning engine, and then into electric energy via the working of an electric machine as generator. A diesel power system is considered for emergency situations as depicts in Fig.10 asynchronous machine of 3.123 MVA connected with diesel engine governor which is generating 3 phase AC power. An excitation system is providing the DC voltage to the field winding of synchronous machine

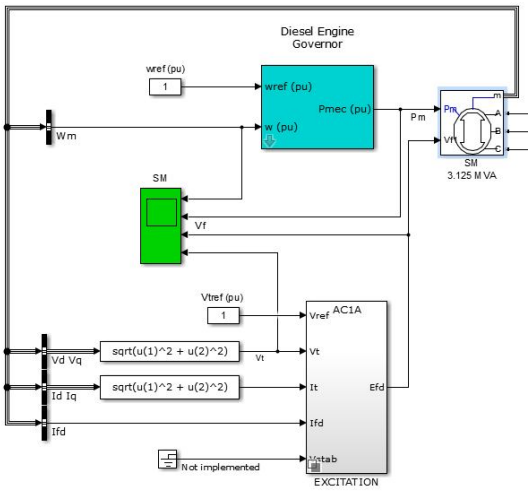

Figure 7. Modelling of diesel generator

5. MODELLING OF INVERTER

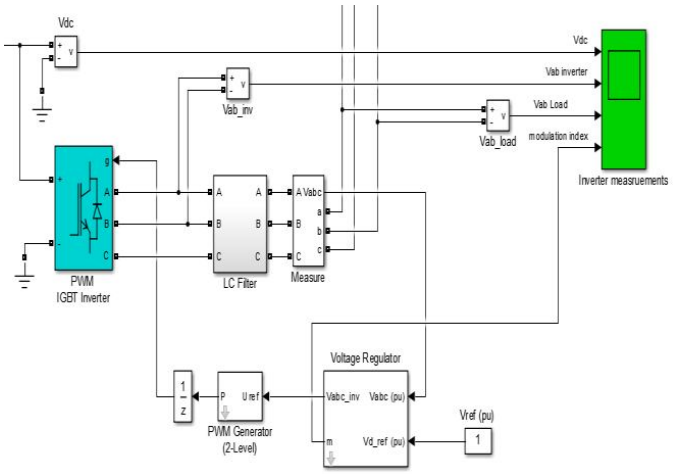

Figure 8. Modeling of inverter

The above figure shows the model of IGBT inverter controlled by PWM which is used to convert the DC power into AC power. A voltage regulator along with a LC filter is being used as the input to PWM generator. DC/AC inverter acts as an interface between the power sources and the loads to provide the required power to the load by regulating the AC output voltage.

IV. RESULT AND DISCUSSIONS

1. solar pv systems

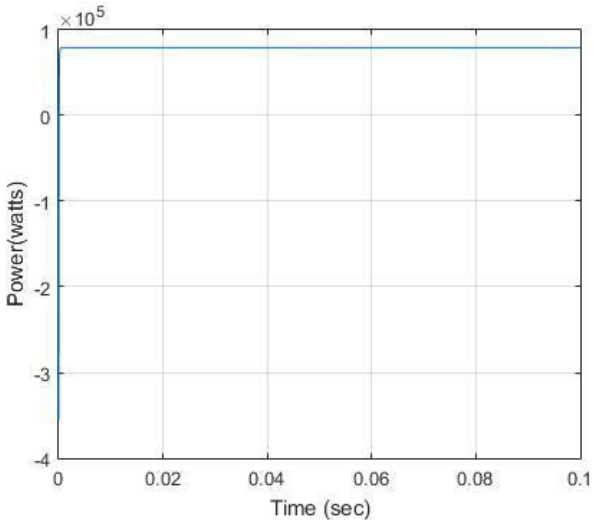

Figure 9. Solar power produced (in watts).

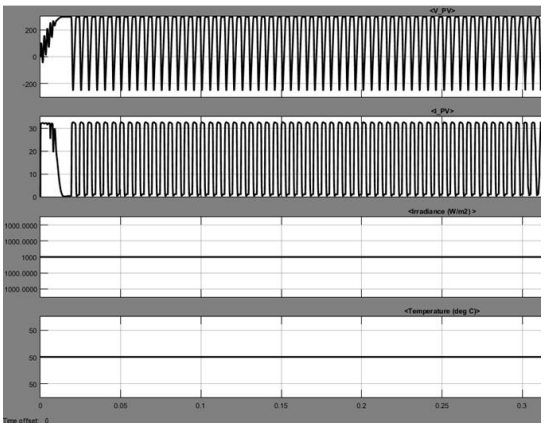

Figure 10. Input voltage and current graph

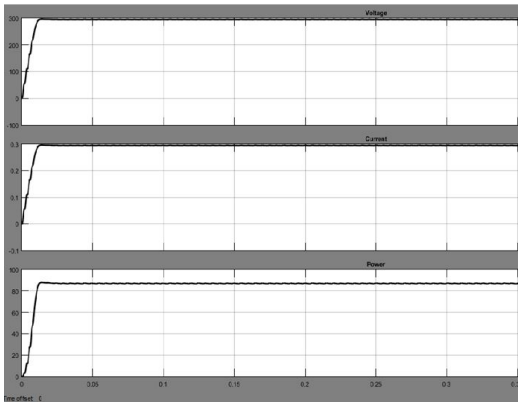

Figure 11. Output voltage, current and power graph

2. wind power generator

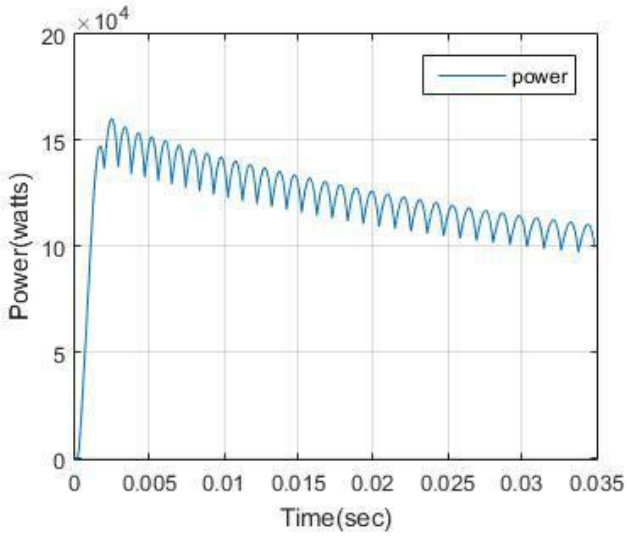

Figure 12. Wind power generation results

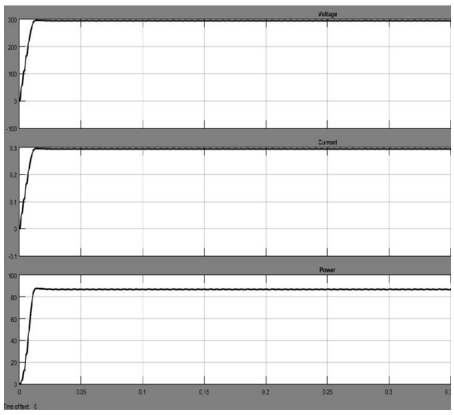

Figure 13. Output voltage, current and power graph

3. Battery

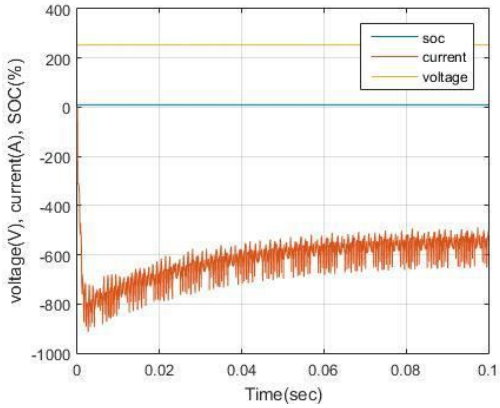

Figure 14. battery characteristics (during charging)

4. Diesel generator

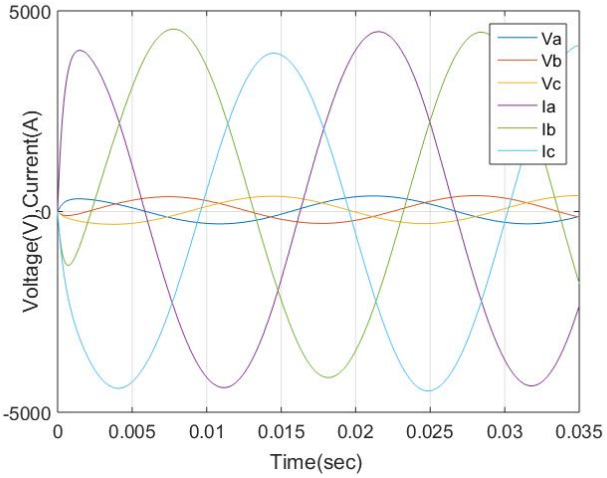

Figure 15. Diesel generation results

5. Inverter

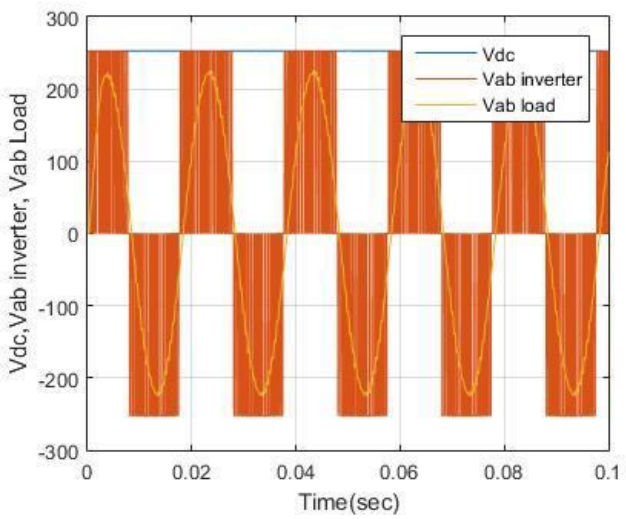

Figure 16. Inverter characteristics

V. CONCLUSION

A proposed model of hybrid power system sources (HPSS) designed and simulated using MATLAB/Simulink. This project investigated the work by connection different power generation system which consist of renewable energy (photovoltaic (PV), wind turbine based permanent magnet synchronous generator (PMSG)), Battery, Diesel generation set power system and Grid which are generating energy for an AC load and with a continuous electric power production to supply the load. The control strategy is utilized for studying this model HPSS to choose the cheapest sources and minim cost to meet the load demand. A power management developed to improve the reliability of hybrid system operation.

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