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Simulation of Hybrid Electric Vehicle Using Solar and Wind With MATLAB

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Abstract— This paper proposes a Hybrid Electric Vehicle (HEV) system which resolves the major glitches of fuel and pollution. The renewable energy is vibrant for today's world as in near coming the non-renewable sources that we are using are going to get bushed. The hybrid electric vehicle is a phase in saving these non-renewable sources of energy. The elementary principle of solar vehicle is to usage energy that is kept in a battery during and after charging it from a solar panel. Power generated by renewable energy sources has newly become one of the most hopeful resolutions for the electrification of islands and distant rural areas. But high reliance on weather conditions and the impulsive nature of these renewable energy sources are the main drawbacks. To overcome this feebleness, changed green energy sources and power electronic converters need to be combined with each other. The charged batteries are used to initiative the motor which attends here as an engine and interchanges the vehicle in reverse or forward direction. This idea, in future, may help to shield our fuels from getting quenched.

I. INTRODUCTION

This paper discusses about the tradition of solar energy and wind energy to power up the vehicle. In directive to attain the compulsory voltage, the Photo Voltaic (PV) Module may be connected either in parallel or series, but its pricier. Thus, to brand it cost operative, power converters and batteries are been used. The electrical charge is combined from the PV panel and wind turbine and focused to the output terminals to harvest low voltage (Direct Current)

An electric vehicle is pollution permitted and is well-organized at low-speed settings mainly in high traffic areas. But battery charging is time uncontrollable. The charge controllers through this power developed from the solar panel and wind turbines to the batteries.

According to the public of the battery, the charging is done, so as to avoid swindling and deep discharge. The voltage is then enhanced up using the boost power converter, eventually running the DC machine which is used as the drive motor for our vehicle submission. In the development work, the distinctive geographies of the components: solar

panel, wind turbine, charge controller, battery, buck boost converter and DC machine required for the vehicle application were intentional in real time and also were modelled independently and the complete software integration of the system into meet up the application's prerequisite.

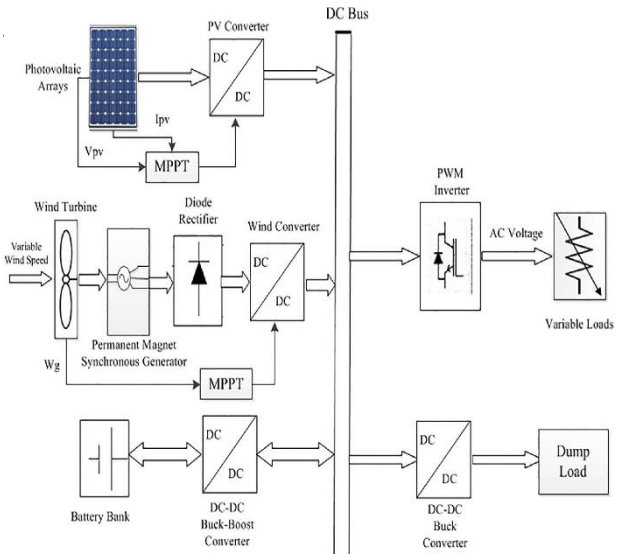

Fig.1 Block diagram of the Wind-Solar hybrid system.

The Fig 1 bounces an indication of the working of hybrid electric vehicle. Energy from Sun is seized by the solar panels

and energy from wind is apprehended by wind turbine is converted to electrical energy. The electrical energy thus fashioned is being fed to the batteries that get exciting and is used to run PMBLDC motor. The shaft of the motor is associated to the rear wheel of the parts.

The batteries are primarily fully charged and thereafter they are charged by panels and wind turbines. This assistances in implementation the incriminating-liquidating rotation of the batteries, which is very significant for proper working of batteries. The operation works according to system desired requirements.

II. RENEWABLE SOURCES AND OTHER DEVICES

2.1 SOLAR PANEL

Solar panel is use to translate solar radiation to the electrical energy. The physical of PV cell is very comparable to that of the classical diode with a PN junction fashioned by semiconductor material. When the junction fascinates light, the energy of captivated photon is transported to the electron-proton system of the material, creating charge carriers that are detached at the junction.

The charge juggernauts in the junction section create a potential gradient, get augmented under the electric field, and circulate as current concluded an external circuit.

Solar array or panel is a assembly of a numerous modules electrically connected in series parallel amalgamation to generate the essential current and voltage. Solar panels are the medium to translate solar power into the electrical power.

2.2 WIND TURBINE

Wind turbine is that system which cuttings energy from wind by turning of the blades of the wind turbine. Fundamentally, wind turbine has two types one is vertical and additional is horizontal.

As the wind speed intensifications power generation is also increases. The power produced from wind is not unceasing its fluctuating. For acquire the non-fluctuating power we have to store in battery and then afford it to the load.

2.3 BUCK BOOST CONVERTERS

Buck boost converters can be very beneficial for high presentation electrical gear applications. Reductions in size and electromagnetic production lengthways with an increase in efficiency, transient response, and reliability are amongst the many recompenses to using such converters. buck-boost converter is a amalgamation of a buck converter and a boost converter i.e., it is a cascade grouping of a buck converter circuit and a boost converter circuit. A buck-boost converter is a dc-to-dc converter by which we can acquire an output voltage superior or reduced than the input voltage. The polarity of the output voltage is contradictory to that of the input voltage.

2.4 RECTIFIER

Rectifier is the development of converting an ac power into dc power. In this hybrid energy system, the ac power from wind turbine is in the form of adjustable and it is transformed into dc with the benefit of rectifier and then deposited in battery. Many electronic circuits use DC voltage for procedure. We can straightforwardly convert AC voltage or current into DC voltage or current by using a device recognized as a p-n junction diode. A p-n junction diode permits electric current to stream in forward bias ailment and blocks the current in reverse bias condition. Merely, a diode allows electric current to flow in one direction only. This exclusive property of diode allows it to act as a rectifier.

2.5 BATTERY BANK :-

We have to choose battery bank size each the load prerequisite so that it should accomplish the requirement of load for manipulative the battery bank size. For upsurge in battery bank size we necessity to connect cell in series so that we can get the bigger battery bank size.

The batteries in the system afford to store the electricity that is fashioned from the wind or the solar power. Any compulsory capacity can be gained by serial or parallel connections of the batteries. The battery that affords the most advantageous operation in the solar and wind power systems are preservation permitted dry type and meanings the superior electrolytes. These batteries afford a perfect performance for extensive discharges. Charging and discharging takes residence in this battery.

III. MODELING OF WIND-SOLAR WITH BATTERY STORAGE HYBRID SYSTEM IN MATLAB

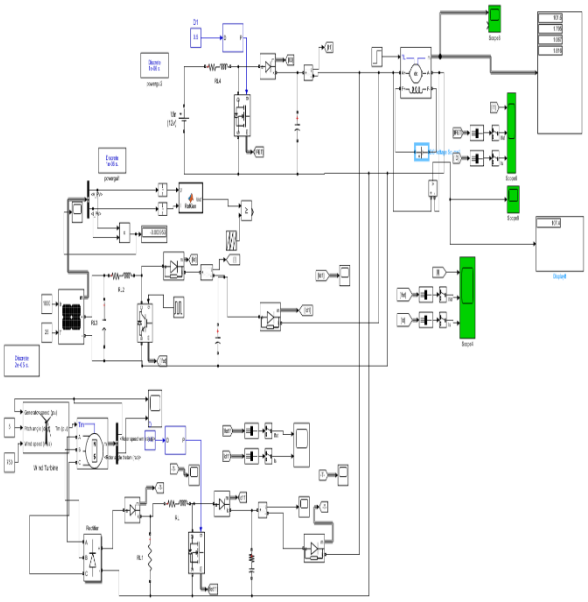

Fig.2 Solar panel / wind turbine / battery fed DC machine

The Solar panel / Wind Turbine / Battery fed DC machine is simulated in MATLAB software as shown Fig 2. The following procedure is followed to achieved the performance of DC machine operation.

1. While designing the solar panel / wind turbine / battery fed DC machine circuit, firstly we designed the buck boost converter, for that we install the MATLAB software 2021a

software. Then open the new model in MATLAB. Click on library find equipment's and combine all components. To get this all equipment's go to Simulink library, and go to simscape, then click on power system then click on fundamental block, click on electrical sources. We can see the voltage source block available, right click on this block and click on add block to the model. It will appear in model, similarly search the all equipment a add on the model.

2. Now arrange the all equipment to connect circuit like the circuit diagram of boost converter connect the positive terminal of RL with the positive terminal of DC voltage source. then branch connect capacitor-resistor positive terminal with diode terminal and negative terminal with the negative terminal of DC voltage source, to complete the circuit. Now connect volt measurement across the DC source and output side of circuit for measure the input and output voltage. Scope is connected to part of the volt measurement to observe the input and output waveform. Now connect PWM generator block with the gate signal of the MOSFET block. At this stage our model is complete according to the circuit diagram of buck boost converter.

3. So, take powergui from the library and bring it in the model. Now we can run the simulation by clicking on the play button. Then double click on scope of input and output voltage to see the input and output voltage. We observe the waveform.

4. The Battery of 48 V is supplied to Buck Boost converter. The output of Buck Boost converter is supplied to DC machine of having specification of 5 HP, 240 V, 1750 RPM. The Buck Boost converter gives voltage of the 92 V. The 92 V is supplied to DC machine to operate at desirable rating. The buck Boost is connected directly to the armature terminal of DC machine to positive and negative point.

5. Wind turbine of 48 V is gets from when turbine rotate at the speed of 750 Rad/sec. The wind turbine operates at 750 Rad/ sec speed with 5 pitch angles. The generator speed terminal is connected to the PMSM (permanent magnet synchronous machine). The A, B, C terminal of PMSM is supplied to diode rectifier. From that the positive and negative terminal is carried out for buck boost converter. The buck boost converter is designed similarly by following the steps of previous circuit diagram of buck boost converter. The Wind Turbine of 48 V is supplied to Buck Boost converter. The capacitor filter is used to smooth out ripple at output voltage.

6. For solar panel, 3 parallel connected panel string with 2 series connected string is installed for solar panel to get desire voltage input of 48 V. The solar panel is connected with 2 constants for irradiance of 1000 and temperature of 25 degree Celsius. The M terminal of solar panel is connected to MPPT (maximum power point tracker). We referred the MPPT design from the research paper. The buck boost converter is designed similarly by following the steps of previous circuit diagram of buck boost converter.

7. The Wind Turbine and battery and Solar Panel and battery of 48 V is supplied to Buck Boost converter. The capacitor filter is used to smooth out ripple at output voltage. The output of Buck Boost converter is supplied to DC machine of having specification of 5 HP, 240 V, 1750 RPM. The Buck Boost converter gives voltage of the 107 V. The buck Boost is connected directly to the armature terminal of DC machine to positive and negative point.

8. The battery to DC machine is a standalone system. The DC machine produces the speed at 101 RPM. The armature current of DC machine is 1.795 A. The field current of DC machine is 1.067 A. The torque at which DC machine operate to work is 1.816 N-m.

IV. SIMULATED OF WIND-SOLAR WITH BATTERY STORAGE HYBRID SYSTEM IN MATLAB

4.1 Simulation of DC machine voltage

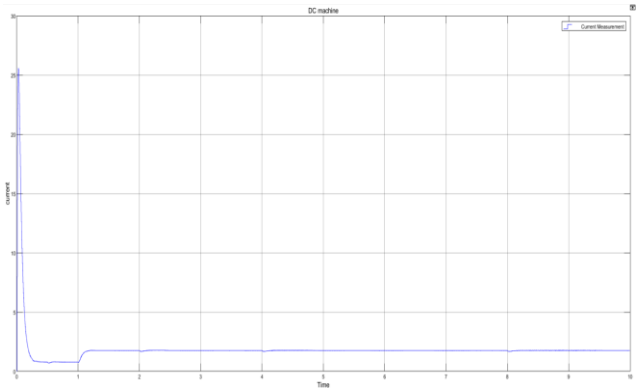

Fig.3 Solar panel / wind turbine / battery fed DC machine voltage

Fig 3 shows the DC machine voltage and its simulation circuit as shown in fig. 2 In this figure blue line indicates the output voltage of battery. The DC machine runs at the 107 V voltage output that indicated in the range of 100 V to 110 V in the simulation.

4.2 Simulation of DC machine current

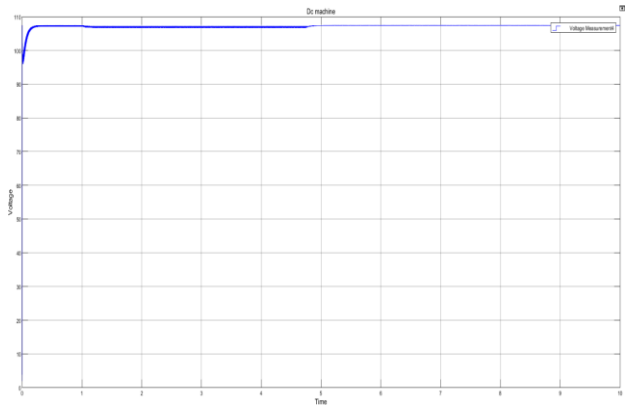

Fig.4 Solar panel / wind turbine / battery fed DC machine current

Fig 4 shows the DC machine current and its simulation circuit as shown in fig.2. In this figure blue line indicates the DC machine current. The DC machine gives the 1.795 A current output that indicated in the range of 0 A to 5 A in the simulation. At starting there is a sudden increase in current at the range of 25 A to 30 A. the current value gets elapsed at point 1 and after that current become constant at 1.793 A.

4.3 Simulation of DC machine speed

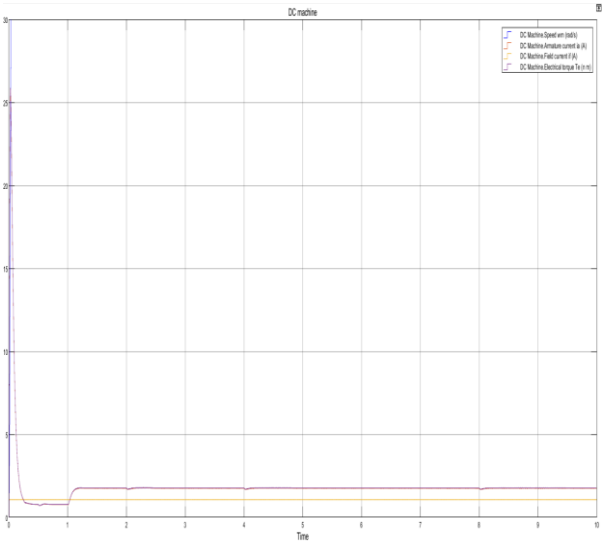

Fig.5 Solar panel / wind turbine / battery fed DC machine speed

Fig 5 shows the DC machine speed and its simulation circuit as shown in fig. 2. In this figure blue line indicates the DC machine speed. The DC machine runs at the 104 Rad/sec speed that indicated in the range of 100 Rad/sec to 110 Rad/sec in the simulation.

4.4 Simulation of DC machine torque

Fig.6 Solar panel / wind turbine / battery fed DC machine torque

Fig 6 shows the DC machine torque and its simulation circuit as shown in fig. 2. In this figure violet line indicates the DC machine torque. The DC machine operate at the 1.816 N-m torque that indicated in the range 0 N-m to 5 N-m of in the simulation.

V CONCLUSION

A hybrid PV-wind renewable power generation system with suitable power management has been considered and demonstrated in this thesis. The power available from green energy sources is exceedingly reliant on on weather situations such as solar irradiations and wind speed. In this paper, a solar system integrated with a wind turbine and battery bank using a analysis situs to overcome this shortage. This standalone hybrid topology shows exceptional performance under fluctuating load power prerequisite, solar irradiation and wind speeds where solar irradiation and wind speed. Based on the simulation fallouts and analysis, it could be determined that the proposed hybrid system can be pleasingly used in the electric vehicle. Future work should purpose at scenery up the proposed hybrid standalone solar-wind system in the Electric vehicle.

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