HIGHROBUSTBATTERYCHARGINGMETHOD FORHYBRIDSYSTEMBYADOPTINGCURRENT CONTROL REGULATIONTECHNIQUE

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Abstract— This paper proposes the new concept of powering standalone load from hybrid renewable energy sources such as solar, wind and fuel cell with a suitable battery backup. Optimization of power flow proposed here is based on the both discrete and continuous control of power supply. The control scheme has more simplicity and robust for efficient battery backup and regulating the power given to load. Simulation work is carried out by using Mat lab /Simulink software and the output is verified for the various natural inputsources.

Keywords- *Fuel cell, Duty cycle, Solar energy, Wind energy, Hybrid system, EB.*

I. INTRODUCTION

The running cost of the standalone load is can be greatly reduced if it is made to run of grid. In areas like Tamil Nadu, India the radiation of the sun is peak over 9 out of 12 months and the southern region expenses the tunneling effect with greater wind velocity therefore by obtaining these renewable sources we can backup power up the standalone load without an deficiency from the Electrical board.

The selection of sources from the proposed system is based on the idea not only for the better power flow but also stand as a substitute in case of the any one supply is cutoff during maintenance. Thus the reliability of the system is very much high. Fig. 1.1 shows the block diagram of the hybrid system.

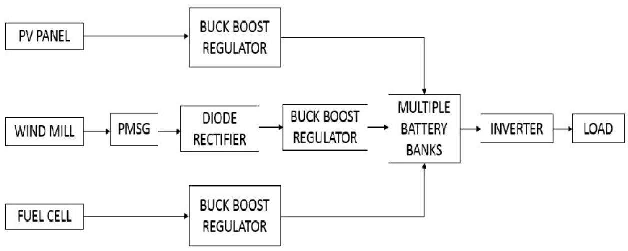

Fig 1.1: Block diagram of the hybrid system

II. SOLAR ENERGYSYSTEM

Solar energy is the very much beneficial energy because the module has only static members. PV panel kept in terrace, open grounds converts the solar light irradiations fallen on them into DC source. The utility from the sun ranges from the time of 8 am to 5 pm. The output of the solar panel is not constant as it is dependent on the irradiation level. Fig 2.1 shows the PV and IV characteristics of the solar.

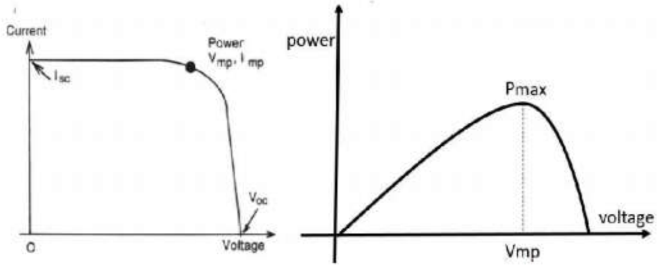

Fig 2.1: pv and iv characteristics of solar

III. FUELCELL

Fuel cell is an electrochemical device that continuously converts the chemical energy of a fuel and oxidant into electrical energy and heat as long as the fuel and oxidant are supplied to the electrodes. A fuel cell is also a battery as it operates on the electrochemical energy conversion principle but there is an important difference a fuel electrochemical battery, but runs on a continuous supply of fuel. This process makes it similar to engines, but engines does not combust the fuel giving out gases, it galvanic ally burns the fuel and the output is voltage and water. A fuel cell achieves the continuous energy transformation from chemical to electrical form with very low pollution and high efficiency making it an excellent choice for power generation. A fuel cell consists of a fuel electrode (anode) and an oxidant electrode (cathode), separated by an ion-conducting electrolyte. Fig 3.1 shows the working of the fuel cell

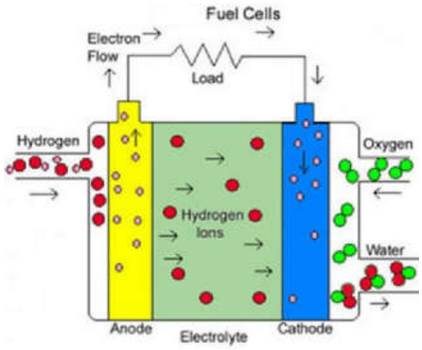

Fig 3.1: Working of the fuel cell

The electrodes are connected externally through a load, thus completing the electronic - ionic circuit. A basic fuel cell with hydrogen as the fuel and oxygen as the oxidant is considered. The hydrogen gas is ionized at the anode to give hydrogen ions and electrons. The electrolyte resists the electronic flow and allows only the ionic flow. Hence the electrons flow through the electrical circuit and reach the cathode after supplying power to the load whereas the hydrogen ions flow through the electrolyte. Oxygen reacts with the electrons and the hydrogen ions to form water. The overall reaction is the sum of the anodic and the cathode reactions results in water production.

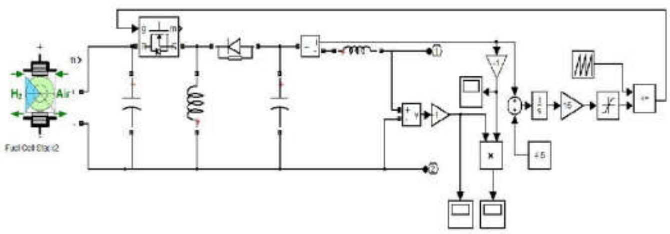

Fig 3.2: Simulink model of fuel cell with buck boost converter

IV. WIND TURBINEGENERATOR

The Simulink model of WTG developed based on PMSG generator is shown in Fig. 4.1. The simulated wind turbine block uses a 2-D lookup table to compute the turbine torque output (Tm) as a function of wind speed and turbine speed. As the PMSG machine operates in generator mode, its speed is lightly above the synchronous speed. According to turbine characteristics, for a 15 m/s wind speed, the turbine output torque is adjusted so as to deliver the power which is 200W.

The torque of the wind turbine is estimated from the basic Electromechanical equation i.e., the torque is power upon generator speed as in the equation.

$$T_m = {Cp(\lambda, \beta)\rho A V^3} / {\omega_m}$$

Where *ωm* is the generator speed, *Cp* the co-efficient of performance, *ρ* the density of air, A the area swept by turbine blade, V is the velocity of wind. Since the system is a standalone system, a capacitor is connected at the output of the asynchronous generator in order to supply the reactive power required by the asynchronous generator for generation of electrical energy.

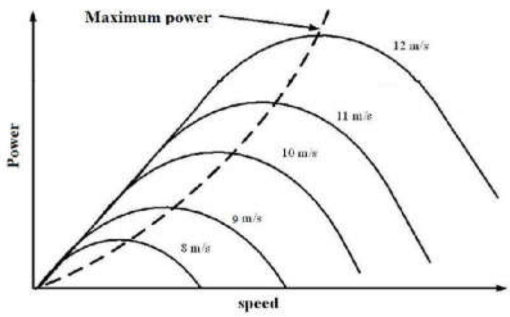

Fig 4.1: Characteristics of wind speed

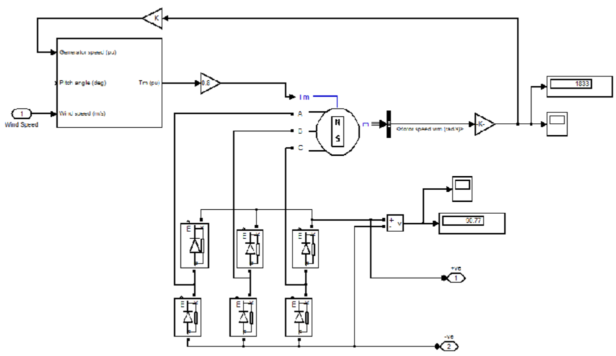

Fig 4.2: Simulink model of wind turbine

V. BUCK BOOSTCONVERTER

The configuration for the step-up and step-down choppers are different from each other, however one circuit topology that can operate in both step-up and step-down modes. It consists of the DC voltage source Vs chopper switch, inductor, diode, capacitor and load. The inductor is to store the energy and release it when required. The capacitor tends to maintain load voltage constant. Fig 5.1 and 5.2 shows the Simulink diagram for the buck boost regulator.

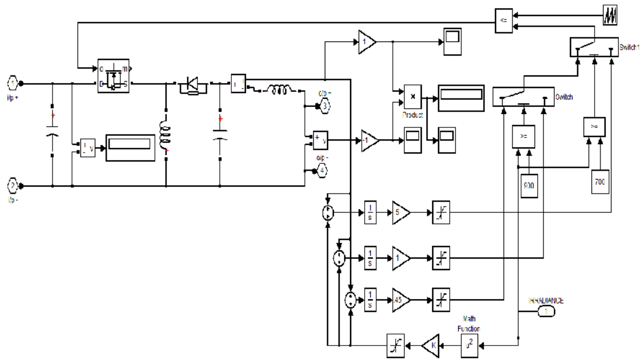

Fig 5..1: Simulink of buck boost regulator for solar

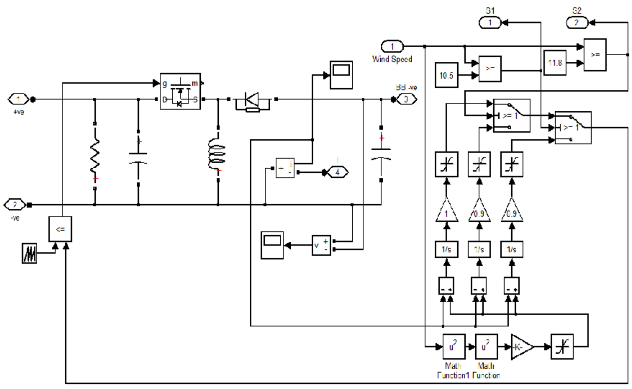

Fig 5.2: Simulation of buck boost regulator for wind turbine generator

VI. BATTERY

Batteries marked negative. In a battery, there are two heavy lead posts have one end or terminal marked positive, while the other is that act as the terminals and which connect to lead plates. The electrons will be collected in the negative plate of the battery. In the electricity that the electrons will flow from the negative to the positive terminal. This is normally done by connecting the battery terminal to a load. The load might be something like a bulb, a motor, a television, or an electric heater.

Battery contains a sulfuric acid solution the sulfur molecules in the battery have bonded to the positive lead plate. Fig 6.1 shows the simulation diagram for the battery bank.

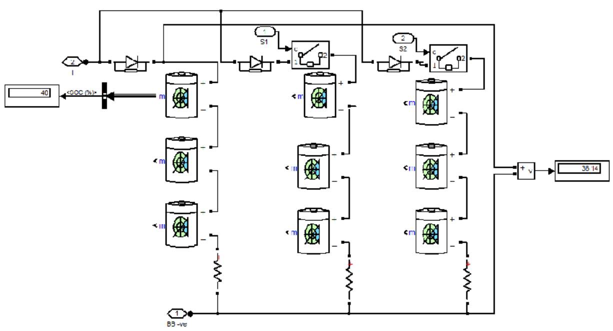

Fig 6.1: Simulink model for battery bank

VII. SOC ESTIMATION OF THEBATTERY

The SOC is defined as the available capacity expressed as a percentage of its rated capacity. The slip-in and slip out of the battery from conduction is also an imperative function which is performed by the power management controller and is set at 40% State of Charge (SOC) as, Depth of Discharge (DOD) to about 70-80% of its capacity shall damage the battery even if it is a deep cycle battery.

According to lead acid battery, the terminal voltage is an index of determining the SOC of battery. The SOC of a 100V battery while charging and discharging is estimated from the terminal voltage and battery current.

VIII. PARAMETERS

Table 8.1: Parameters for solar panel

S.No	PARAMETERS	SPECIFICATIONS
1.	Irradiance	1000
2.	Temperature	25*C
3.	Peak current	11.25 A
4.	Solar voltage	21 V
5.	Series resistance	0.24 ohm
6.	Parallel resistance	1.71 ohm
7.	Power output	200 W

Table 8.2: Parameters for wind turbine generator

S.No	PARAMETERS	SPECIFICATIONS
1.	wind speed of turbine	12 meter/second
2.	Torque	0.8 Nm
3.	Inertia	$2.26e^{-4}kgm^2$
4.	Shaft speed	3000 rpm
5.	Mechanical power	251 V
6.	Electrical power	169 V
7.	Power	188.8 W

Table 8.3: Parameters for fuel cell

S.No	PARAMETERS	SPECIFICATIONS
1.	Voltage at 0A and 1A	42V and 35 V
2.	Nominal operating point	Current = 52A Voltage = 24.5V
3.	Maximum operating point	Current = 100A Voltage = 20V
4.	Voltage output	60 V
5.	Current output	3.3 A
6.	Power output	200 W

These parameter values are for the constant irradiance in solar and for constant wind speed. For the variable wind speed and the irradiance the parameters are tabulated.

Table 8.4: Parameters for multiple irradiance values

IRRADIANCE	VOLTAGE	CURRENT	POWER
1000	17.96	11.22	199.1
900	17.7	9.3	164.8
800	16.53	7.87	130.1
700	14.12	7.06	99.71
600	12.07	6.06	73.26
500	10.09	5.04	50.87

Table 8.5: Parameters for variable wind speed

Wind Power	12	11	10	9
Torque	0.8	0.7	0.6	0.5
Mechanical Power	251	191	135	100
Electrical Power	169	128	90	50

Dc Voltage	105	93	80	70
Speed	3000	2586	2140	1725
Duty Cycle	26.5%	29%	32.5%	35%

IX. SIMULATIONOUTPUT

1. The speed, voltage and current output for the variable wind speed

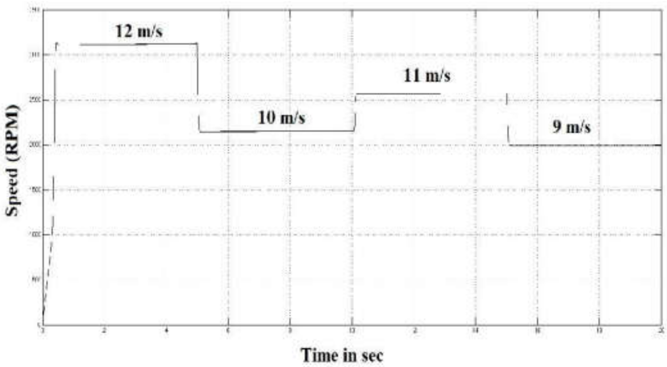

Fig 9.1: Output speed for wind turbine generator

The graph indicates the variable speed of the generator system by varying the wind speed which is shown in the fig9.1.

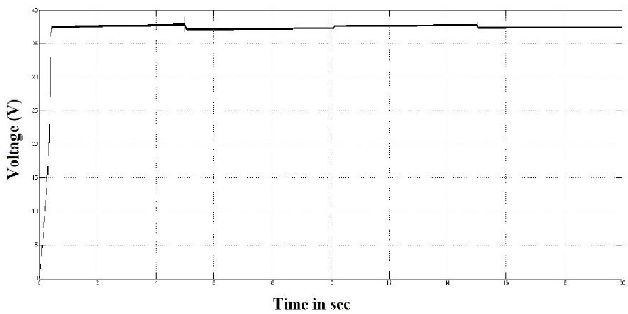

Fig 9.2: Output voltage for wind system

36V of the voltage output obtains from the wind turbine system at any variable wind speed.

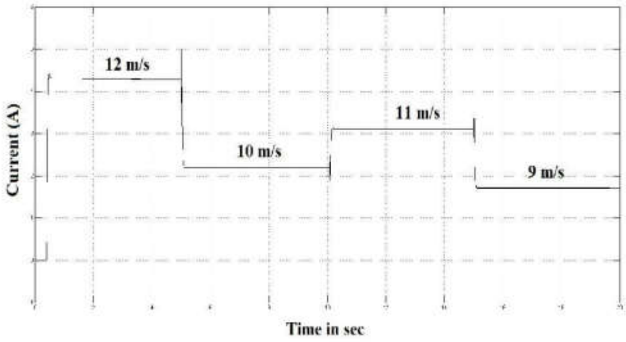

Fig 9.3: Output current for wind system

The graph indicates the variable current values of the generator system by varying the wind speed which is shown in the fig 9.3.

2. The voltage and current output for the fuel cell system.

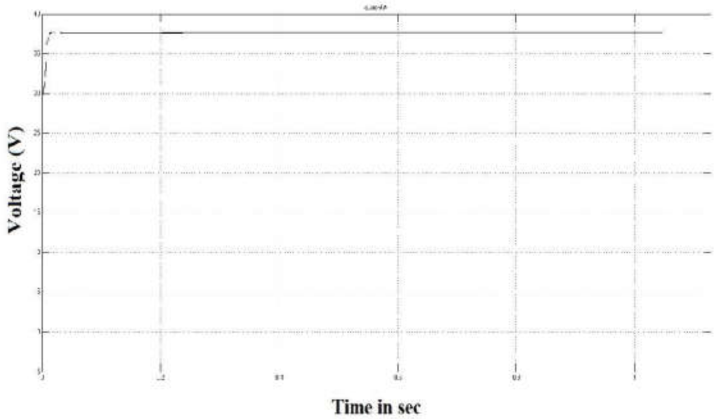

Fig 9.4: Output voltage for fuel cell

Fuel cell obtains the 36V of output voltage which is shown in the fig 9.4.

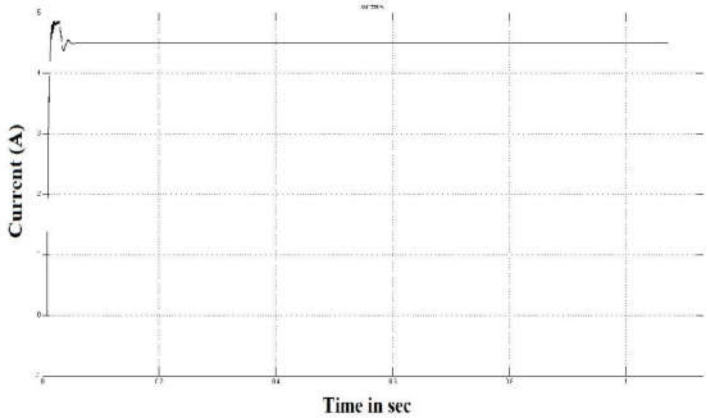

Fig 9.5: Output current for the fuel cell

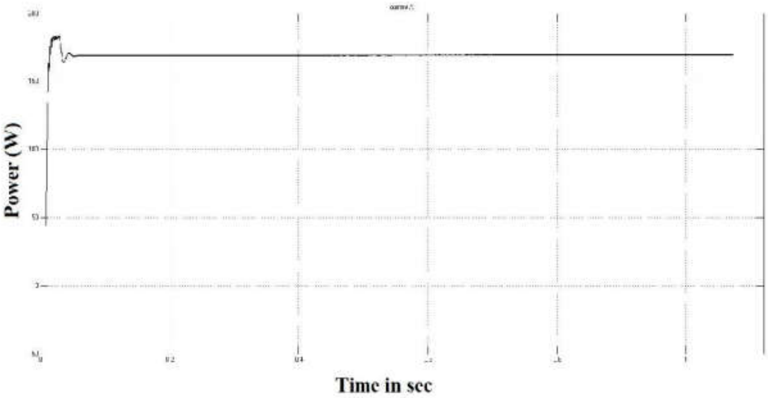

Fig 9.6: Output power for the fuel cell

3. The current and voltage output for the solar power system

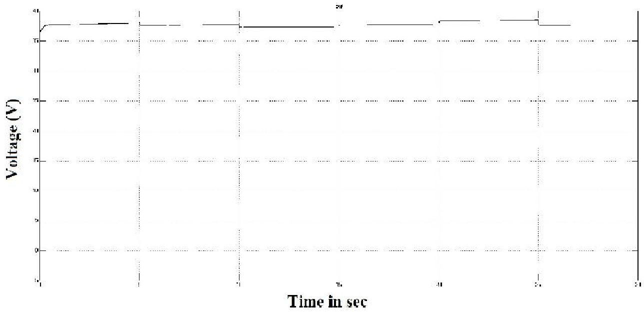

Fig 9.7: Output voltage for solar panel

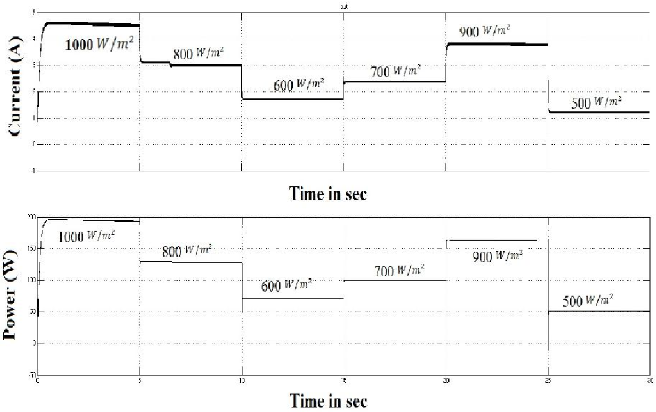

Fig 9.8: Output current and power for solar panel

X. INVERTER

A device that converts DC power into AC power at preferred output voltage and frequency is known an Inverter. Phase controlled converters when operated in the inverter mode are called line commutated inverters. But at line commutated inverters require at the output terminals an existing AC supply which is used for their commutation.

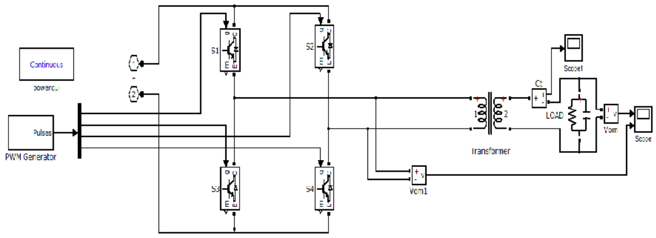

Fig 10.1: Simulink model for inverter system

In this inverter model the all the sources are connected. By applying variable controller performance the power is supplied to compensate the load demand.

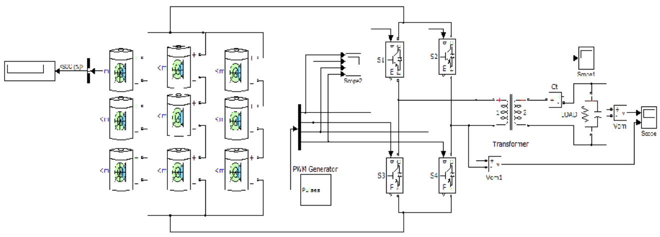

Fig 10.2: Inverter connected to multiple battery banks

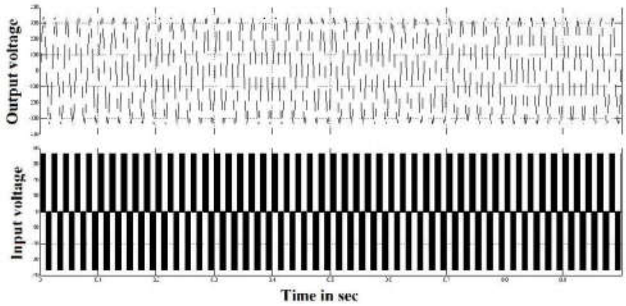

Fig 10.3: Input and output voltage for inverter

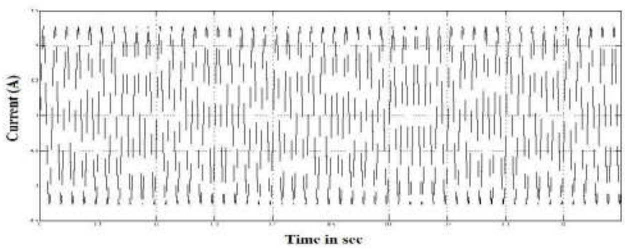

Fig 10.4: Output current for inverter

XI. CONTROLLERPERFORMANCE

Based on the power delivered by the sources, the PI controller combines the sources in any possible ways to meet the load demand. Also it is integrated with the multiple-input converter and performance of the controller is ascertained to be functioning well as stimulated from the simulation output of the system for a controlled input applied at the input of various sources for varying and fixed load demand.

CASE 1

- Power delivered by solar and wind at the output is higher than load demand it triggers the buck boost converter connected to solar and wind.
- It also charges the battery by triggering the battery charger.

CASE 2

- If solar and wind is lesser than load demand the controller discharges the battery suitably to meet the varyingload.

CASE 3

- If the battery discharging is less than 40% we connect the fuel cell which controls the power produced in the fuel cell by adjusting the flow rate controller that controls the hydrogen supply.

XII. SYSTEMPERFORMANCE

Solar panel design is considered with the value chosen of photo voltaic panel with maximum power delivering capacity of 200W at 1000 irradiance. The open circuit voltage is 21V and the short circuit current is11.25A.

The battery bank is designed with three 12V battery of 10AH capacity. The charging current is 15% of the rated AH. Therefore the power consumed for 1 battery bank charging is kept 55 watt with maximum charging rate of1.5A.

Therefore if the solar irradiance varies from 500 to 600 then 1 battery bank can be used. If the irradiance varies from 600 to 700 then 2 battery banks can be used. If the irradiance is more than 700 irradiance then 3 battery banks can be used.

The controller is made such that current feedback of 1.5A is set. The error value is integrated and duty cycle is computed and fed as pulse at the frequency of 20 KHz.

Similarly if the wind speed varies from 8 m/s to 9 m/s then 1 battery bank can be used. If the wind speed varies from 9.5 to 10.5 m/s then 2 battery banks can be used. If the wind speed is more than 11 m/s then 3 battery banks can be used.

The fuel cell is hydrogen system is kept in last values of preferred values when the stored energy in all the battery are used and there is no sufficient power of solar and wind of 200W is generated.

Inverter is built with the 1 phase P.W.M. the inverter conversion ratio is 36V D.C. to 18 V AC. Here the switching frequency is 20 kHz and the modulating frequency is 50Hz for Indian system. The transformer ratio is 18V to 230 V AC and fed to the load.

XIII. CONCLUSION

Work has been done with renewable resources beneficially to extract electrical power with the help of simulation this project concludes the optimum power regulation for standalone is done with the multiple power extraction from renewable energy sources and the power is delivered to the load by suitable inverter.

XIV. REFERENCE

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