International Journal Of Applied Research In Science And Engineering *ISSN (Online): 2456-124X*
International Conference on Emerging Technologies in Engineering, Biomedical, Medical and Science
(ETEBMS - November 2016)

REVIEW ON SOLAR PHOTOVOLTAIC AND WIND POWER PLANT BASED RENEWABLE HYBRID POWER SYSTEM

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Abstract: Renewable energy is derived from natural processes that are replenished constantly. The different renewable energy sources which are generally used are solar, wind, ocean, hydropower, biomass, geothermal energy, etc. Each of these sources has unique characteristics which influence how and where they are used. For fulfilling the global energy demand hybrid energy system is the better option. Hybrid energy system is the integration of wind, solar, hydro etc different renewable energy sources to that of existing transmission distribution system. In recent year's generation of electricity using the different types of renewable sources are increased specifically solar power & wind power has received considerable attention worldwide. This paper presents the review on solar and wind hybrid energy sources and their role and working of their individual performance. It also cover description of power output from PV plant and wind power plant power delivered to grid. We can also provide the storage system of battery to improve the performance of proposed hybrid system and also increase the operational hour and capacity of the hybrid system. All the proposed system design and configuration with the controlling system is done in MATLAB/SIMULINK software and we can also done the analysis in this software.

INTRODUCTION

Rapid depletion of fossil fuel resources on a worldwide basis has necessitated an urgent search for alternative energy sources to cater to the present days' demand. . Therefore, it is imperative to find alternative energy sources to cover the continuously increasing demand of energy while minimize the negative environmental impacts Recent research and development of alternative energy sources have shown excellent potential as a form of contribution to conventional power generation systems.

There is a huge potential for utilizing renewable energy sources, for example solar energy, wind energy, or micro-hydropower to provide a quality power supply to remote areas. The abundant energy available in nature can be harnessed and converted to electricity in a sustainable way to supply the necessary power demand and thus to elevate the living standards of the people without access to the electricity grid. The advantages of using renewable energy sources for generating power in remote islands are obvious such as the cost of transported fuel are often prohibitive fossil fuel and that there is increasing concern on the issues of climate change and global warming. The electric power generation system, which consists of renewable energy and fossil fuel generators together with an energy storage system and power conditioning system, is known as a hybrid power system. A hybrid power system has the ability to provide 24 hour grid quality electricity to the load. This system offers a better efficiency, flexibility of planning and environmental benefits compared to the diesel generator stand-alone system. The maintenance costs of the diesel generator can be decreased as a consequence of improving the efficiency of operation and reducing the operational time which also means less fuel usage. The system also gives the opportunity for expanding its capacity in order to cope with the increasing demand in the future.

This can be done by increasing either the rated power of diesel generator, renewable generator or both of them. The disadvantage of standalone power systems using renewable energy is that the availability of renewable energy sources has daily and seasonal patterns which results in difficulties of regulating the output power to cope with the load demand. Also, a very high initial capital investment cost is required. Combining the renewable energy generation with conventional diesel power generation will enable the power generated from a renewable energy sources to be more reliable, affordable and used more efficiently.

Solar power

Solar panel is a device that converts solar energy directly into electrical energy. Solar panel is made up off photovoltaic cells which are made by semiconductor. When sun beam is fall on the PV cell they absorb the heat and electron are emitted from the atom. Due to the movement of the electron current is generated. With this process solar panel, convert solar energy directly into the electric energy. Photovoltaic is known as the process between radiation absorbed and the electricity induced. Solar power is converted into the electric power by a common principle called photoelectric effect. The basic unit of a photovoltaic power system is the PV cell, where cells may be grouped to form panels or modules. The panels then can be grouped to form large photovoltaic array that connected in series or parallel. Panels connected in parallel increase the current and connected in series provide a greater output voltage.

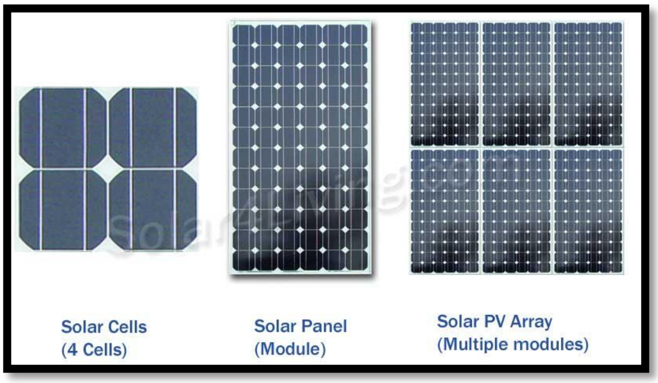

Fig-1 PV Cell, PV Module, PV Array

Fig-2 Solar PV System

The energy generated by the sun radiation is calculated by the formulae:

$P = A \cdot x^2 + B \cdot x + C$ (in Watts)

Where,

X = Solar radiation

P= Power Formation

And A,B,C are constant

By the above formula, we can calculate the amount of power generated by the Sun.

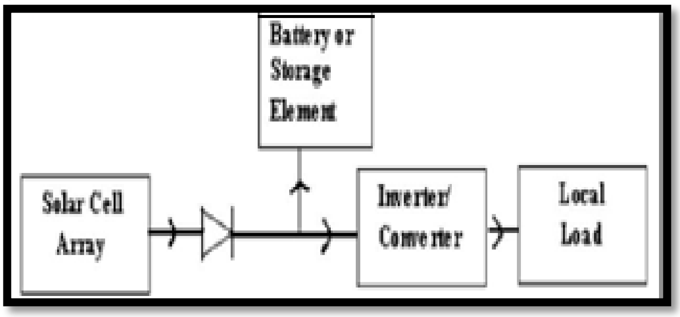

Fig-3 Basic PV System

Storage batteries as shown in Fig. provide the backup power during cloudy weather to store the excess power or some portion of power from the solar arrays. This solar power generating system is used for domestic power consumption, meteorological stations and entertainment places like theatre, hotel, restaurant etc.

Wind Power

The wind energy is a renewable source of energy. Wind power involves converting wind energy into electricity by using wind turbines. A wind turbine is a machine that converts the kinetic energy in wind into mechanical energy. The energy production by wind turbines depends on the wind velocity acting on the turbine. Wind power is able to feed both energy production and demand in the rural areas.

The main drawback of this system is that as the wind speed or velocity is not constant with respect to time i.e. fluctuating, hence the electric power thus obtained is also does not have a fixed value i.e. varying nature. Thus, it is better to feed the wind electricity to the battery or any power storage device, which supply the load consecutively, rather than directly supply to the load as shown in fig.

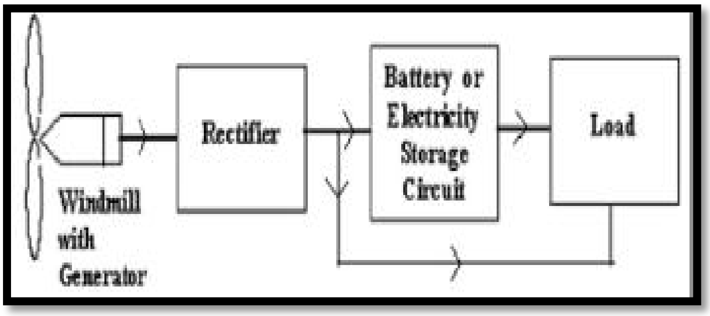

Fig-4 Basic Wind Power System

The power output of a turbine is a function of the cube of the wind speed, so as wind speed increases, power output increases dramatically. Areas where winds are stronger and more constant, such as offshore and high altitude sites are preferred locations for wind farms. We cannot convert all the wind energy into electricity: we can convert only 59%, according to Betz limit. The output equation for a wind generator is given by:

$P = (1/2) \times \rho \times A \times v3$ (in Watts)

Where,

A=area perpendicular to the direction of flow (in m2),

v=wind velocity (ms-1),

ρ =density of air (in Kgm-3) and

P=power generation.

In wind power system, the power generation increases in proportion to the cube of the wind speed. Thus it is highly affected in rainy and stormy season when the wind speed is too less to produce electricity. This power generation system is pollution free and ecologically balanced.

A general characteristic curve that describes the wind turbine output power variation with steady wind speed is shown in Figure

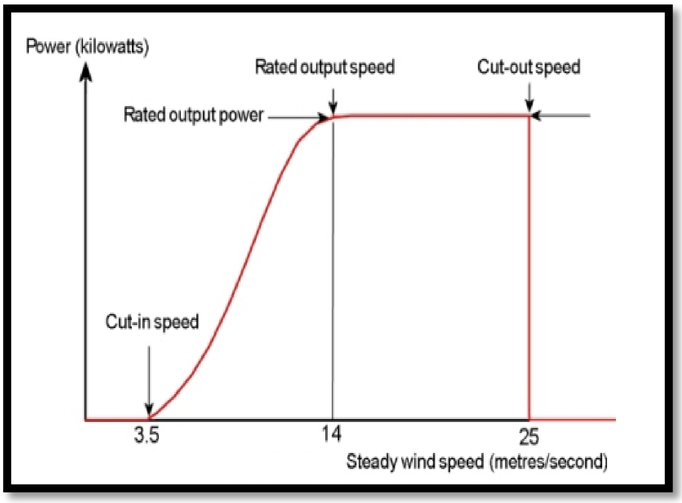

Fig-5 Wind Turbine Power Output Verses Steady Wind Speed Characteristics

From the above characteristic curve, there are three important points at which much attention is paid for the speeds and the corresponding turbine output powers for every wind turbine. These are the cut-in speed, rated output speed and cut-out speed.

Hybrid Power Generation System

A typical hybrid system combines two or more energy sources, from renewable energy technologies such as PV-panels, wind or small hydro turbines; and from conventional technologies usually diesel Gensets. In addition, it includes power electronics and electricity storage bank.

Our proposed hybrid system is designed for both on grid and off grid operation to reduce dependency on the national grid for electrical supply. The "fig." shows the block diagram of a typical hybrid grid connected power system. The system consists of PV generators, wind generator, biogas, biomass (rice husk), micro-hydro, battery bank, battery charge controller and the dump load.

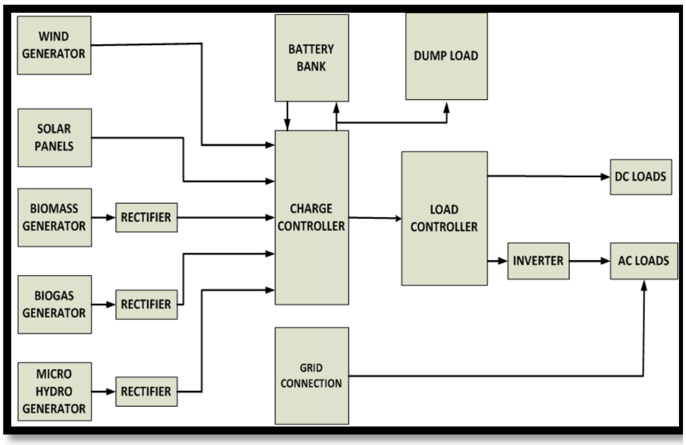

Fig-6 Hybrid Generation System

Grid Tie PV/ Wind Hybrid System

These systems can be classified in terms of their connection to the power system grid into the following:

A. Centralized AC-bus architecture

In this architecture, the generators and the battery are all installed in one place and are connected to a main AC bus bar before being connected to the grid .This system is centralized in the sense that the power delivered by all the energy conversion systems and the battery is fed to the grid through a single point. In this case, the power produced by the PV system and the battery is inverted into AC before being connected to the main AC bus.

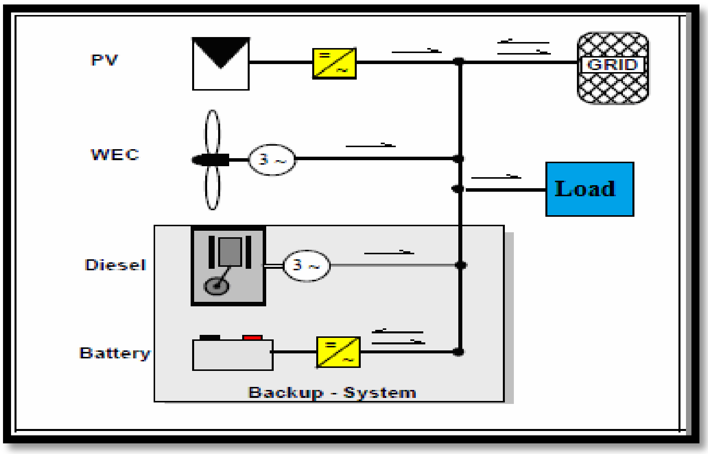

Fig-7 Centralized AC-bus architecture

B. Centralized DC-bus architecture

The second architecture utilizes a main centralized DC bus bar as in figure. The wind turbine and the diesel generator, firstly deliver their power to rectifiers to be converted into DC before it is being delivered to the main DC bus bar. A main inverter takes the responsibility of feeding the AC grid from this main DC bus.

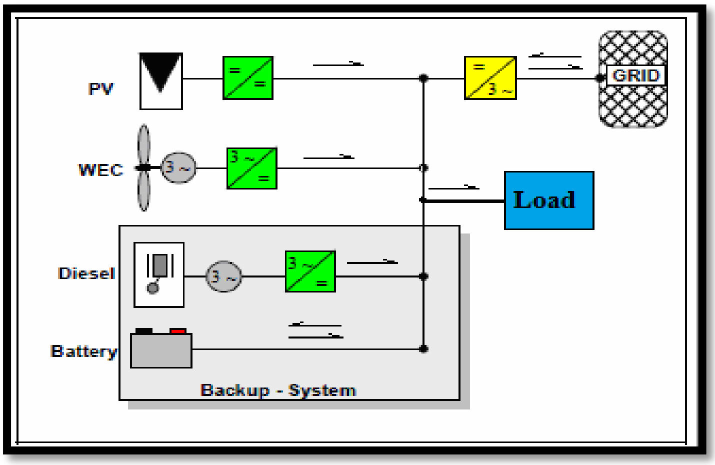

Fig-8 Centralized DC-bus architecture

C. Distributed AC-bus architecture

The power sources in this architecture do not need to be installed close to each other as in figures, and they do not need to be connected to one main bus bar. Otherwise, the sources are distributed in different geographical locations as appropriate and each source is connected to the grid separately. The power produced by each source is conditioned separately to be identical with the form required by the grid. The main disadvantage of this architecture is the difficulty of controlling the system.

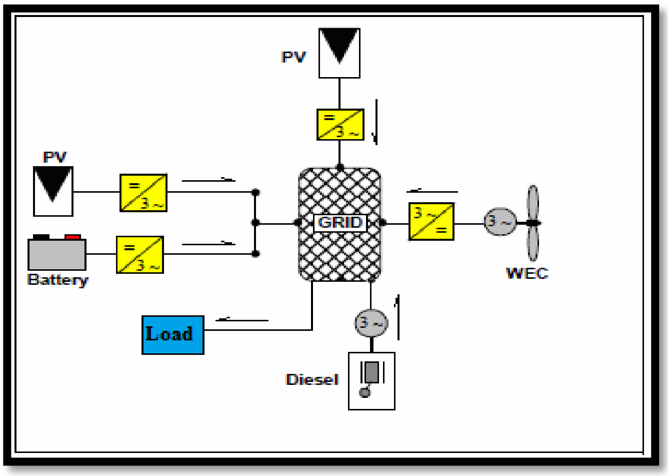

Fig-9 Distributed AC-bus architecture

D. Modified Distributed Ac Bus Architecture

The following architecture is the one upon which the submitted thesis is based. It is an improved version of the distributed AC-bus architecture shown in above figure.The improvement exists mainly in the addition of a DC/DC converter for each energy conversion system and the remove of storage battery. By this addition of the DC/DC converters, the state values of the energy conversion sources become completely decoupled from each other and from the state values of the grid the power production of the different sources becomes now freely controllable without affecting the state values of the grid.

Decoupling the state values means that the variations of the renewable resources like the velocity of the wind and the intensity of the solar radiation will not influence the state values of the electrical grid.

The main disadvantage of this architecture is the difficulty of controlling the system, but this problem is not effective since the improvement of wireless communications.

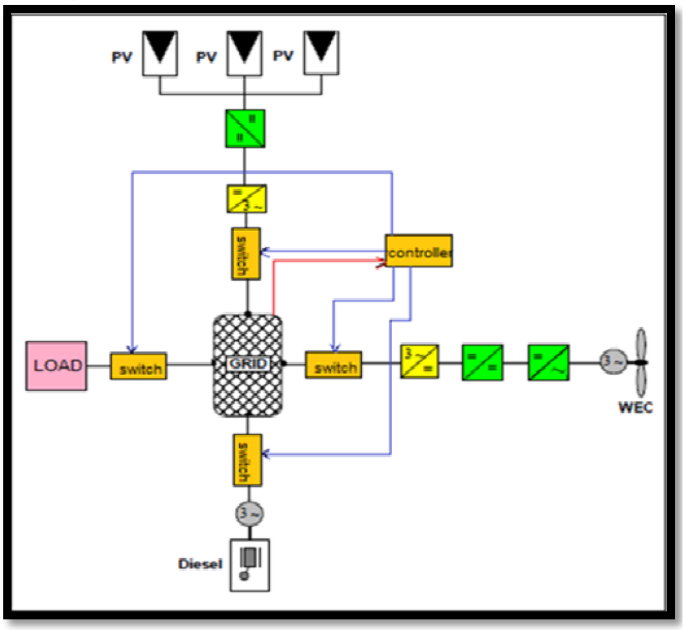

Fig-10 The modified distributed Ac bus architecture.

MODELLING AND SIMULATION OF PV

Modeling and Results of Solar-PV System:-

A 30 KW panel is considered as consisting of 24,080 solar cells arranged in 344X70 combinations. The solar array consists of number of panels connected in series-parallel configuration and a panel consists of number of cells. The power characteristics of the solar cell are formulated using its equivalent circuit. The equivalent circuit of the cell is presented as a current source in parallel with diode and a parallel resistance with a series resistance.

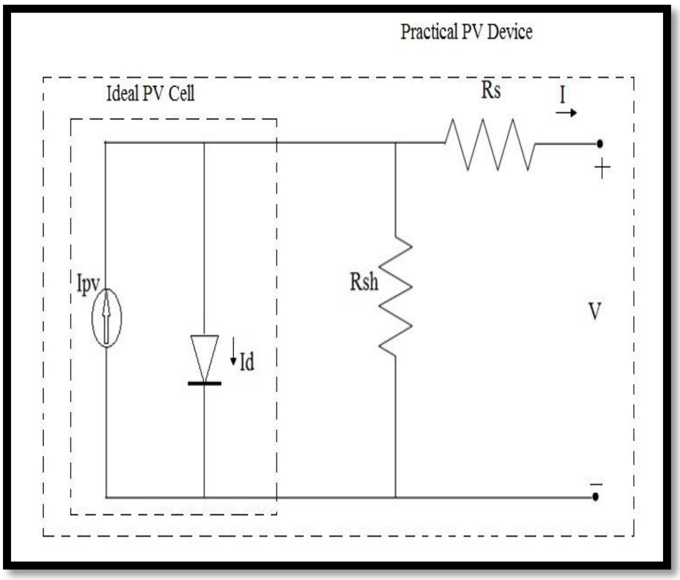

Fig-11: Equivalent circuit of a practical PV device [6]

The output current can be measured by subtracting the diode currents and current through resistance from the light generated current. From this circuit, the output current of the cell is expressed as,

$$I = Ipv - Id - I_{Rsh} \quad (1)$$

$$I = Ipv - I_0\left[\exp\left(\frac{V+IRs}{a}\right) - 1\right] - \left(\frac{V+IRs}{Rp}\right) \quad (2)$$

Where, $a = \frac{NS.A.K.Tc}{q} = Ns.A.V_T$

$$\frac{Isc + Kv * dT}{\exp\left(\frac{Voc+Kv*dT}{a*V}\right) - 1}$$

Where, ns are numbers of cells connected in series. The output current of the solar panel is I. The light generated current is Ipv. Saturation currents through diodes are I_0. The voltage at output of panel is V Series resistance of cell is Rs which represents the internal resistance of cell and it is considered as 0.55 Ω. The Boltzmann's constant is K (1.38 X 10^{-23} J/K). Ambient temperature (in Kelvin) is T and charge constant is q (1.607 X 10^{-19}C).

A 30 KW solar-PV array is realized considering 24,080 cells (344×70 dimensions) using (1)-(2). A Matlab model for the same is developed.

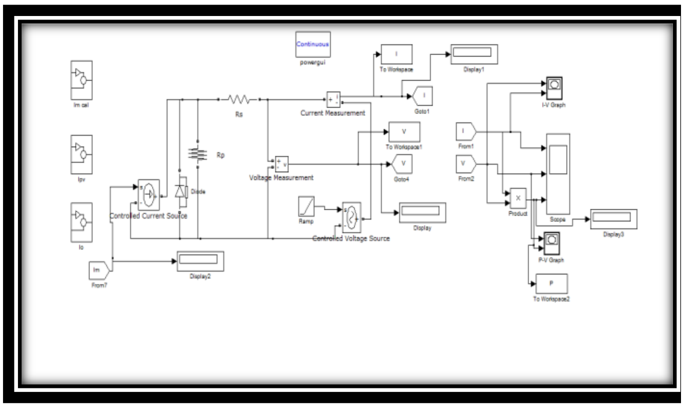

Fig 12: Simulink model of a PV device

Table 1: Parameters of the PV module at 25^{0}C, 1000 W/m^2 [6]

Imp	2.88 A
Vmp	17 V
Pmp	49 W
Isc	3.11 A
Voc	21.8 V
Rs	0.55 Ω
Kv	-72.5×10^{-3} V/K
Ki	1.3×10^{-3} A/K
Ns	36

RESULTS:-

After the simulation, we obtained the following results,

Simulation Results of solar panel

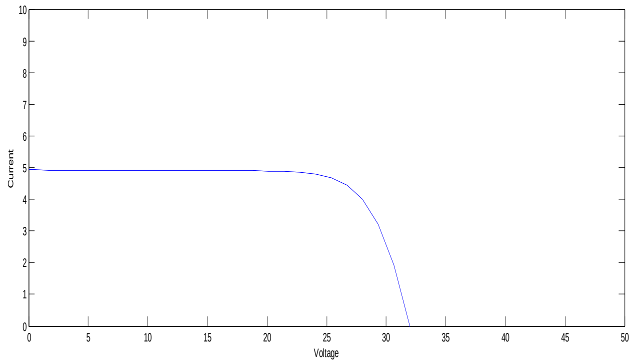

Fig 13-I-V Characteristic

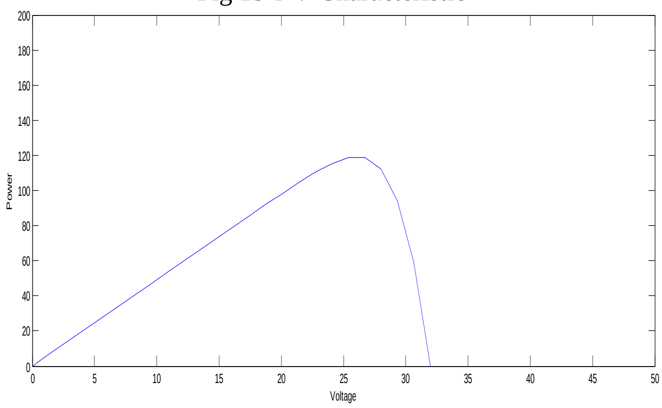

Fig 14-P-V Characteristic

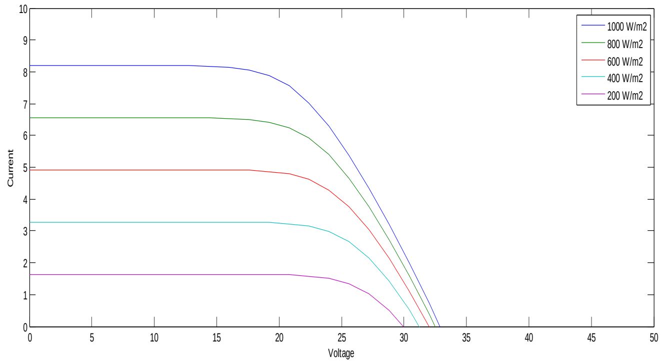

Fig 15-Diiferent Radiation I-V Characteristic

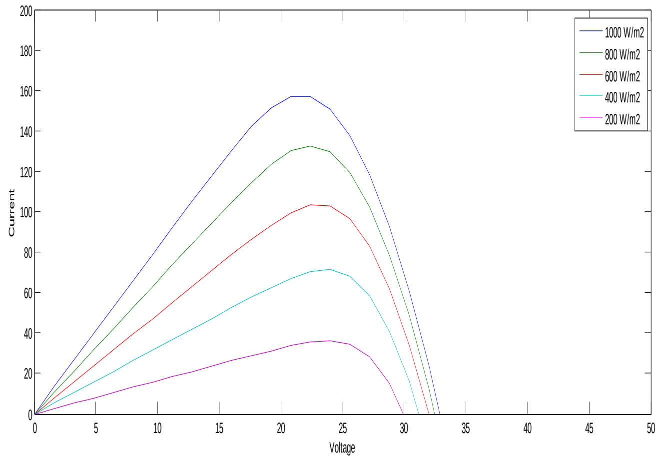

Fig 16-Diiferent Radiation P-V Characteristic

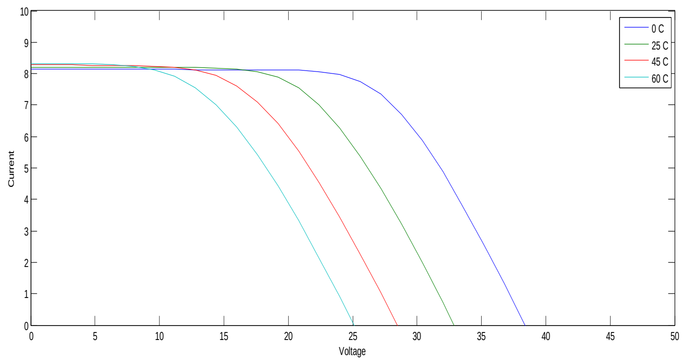

Fig 17-Diiferent Temperature I-V Characteristic

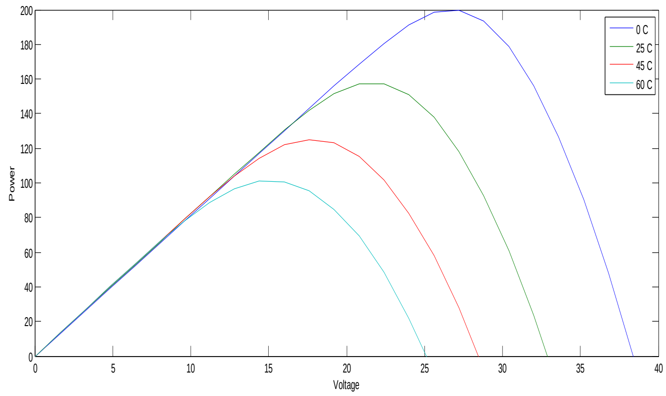

Fig 18-Diiferent Temperature P-V Characteristic

Conclusion

This paper presents a hybrid wind/PV energy system for standalone system. The standalone hybrid system is better than a single energy source. The wind energy systems may not be technically viable at all sites because of low wind speeds and being more unpredictable than solar energy. The combined utilization of these renewable energy sources is therefore becoming increasingly attractive. This Paper also highlights the future developments, which have the potential to increase the economic attractiveness of such systems and their acceptance by the user. This Paper also represents the modeling and Simulation of Solar PV System using MATLAB-SIMULINK software. The Simulation results show the ideal I-V and P-V characteristics of the solar PV system.

REFERENCES

[1] Anjali Rana, Mohammad Ilyas, "Implementation of a Wind/PV Hybrid System using MATLAB/Simulink", Vol. 4, Issue 7, July 2015, International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, ISSN (Print) : 2320 – 3765 ISSN (Online): 2278 – 8875.

[2] Yerra Sreenivasa Rao, A. Jaya Laxmi and Mostafa Kazeminehad, "Modeling and control of Hybrid Photovoltaic Wind Energy conversion system", International Journal of Advances in Engineering & Technology, May 2012, ISSN: 2231-1963.

[3] J.Godson, M.Karthick, T.Muthukrishnan, M.S.Sivagamasundari, "Solar PV-Wind hybrid power Generation system", Vol. 2, Issue 11, November 2013, International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, ISSN (Print) : 2320 – 3765 ISSN (Online): 2278 – 8875.

[4] Sandeep Kumar, Vijay Kumar Garg, "A Hybrid model of solar-wind Power generation system", Vol. 2, Issue 8, August 2013, International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, ISSN (Print) : 2320 – 3765 ISSN (Online): 2278 – 8875.

[5] Ashish S. Ingole, Prof. Bhushan S. Rakhonde, "Hybrid Power Generation System Using Wind Energy and Solar Energy", International Journal of Scientific and Research Publications, Volume 5, Issue 3, March 2015 ISSN 2250-3153.

[6] Ghassan HALASA, Johnson A. ASUMADU, "Wind-Solar Hybrid Electrical Power Production to Support National Grid: Case Study – Jordan", Energy and Power Engineering, 2009, 72-80 doi:10.4236/epe.2009.12011 Published Online November 2009.

[7] Shashi Shanker, BSSPM Sharma, "Optimization of Solar and Wind Hybrid System", Volume 3 Issue 8, August 2014, International Journal of Science and Research (IJSR) ISSN (Online): 2319-7064.

[8] International Energy Agency; www.iea.org

[9] BP Statistical Review of World Energy; June 2012

[10] Planning Commission, Government of India; www.planningcommission.nic.in

[11] Energy Information Administration; www.eia.gov

[12] The World Fact Book, Central Intelligence Agency; www.cia.gov

[13] Ministry of Power; Government of India; www.powermin.nic.in