Journal of **N**onlinear **A**nalysis and **O**ptimization
Vol. 14, Issue. 2 : 2023
ISSN : **1906-9685**

HYBRID POWER GENERATION AUTOMATION AND PREDICTION USING STANDALONE HYBRID SOLAR P-V WIND ENERGY SYSTEM

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ABSTRACT
This study proposes to combine p-v solar and wind sources into one and to enhance the functionality of the current power grid such that, even if one source is not operational for whatever reason, the grid may still function thanks to the other source. All traditional energy sources are currently becoming more and more scarce. Without damaging the environment, this activity stimulates the sustainable energy ex-chequer. Future conventional electricity generation will be a challenging task. In order to harness the power from the suggested hybrid energy system in an efficient and reliable manner, a solar photovoltaic system, a wind energy system, and a battery bank are integrated via a common dc link architecture. Individual components such as batteries, IGBTs, inverters, solar panels, and batteries are used in hybrid energy system are deliberated in the modelling process. We suggest that a standalone hybrid solar p-v wind energy system for applications in remote area.
Keywords: photovoltaic, inverter, wind system, ex-chequer,hybrid energy system

1. INTRODUCTION

Numerous efforts have been made to create effective renewable energy conversion systems as a result of the recent focus on renewable energy sources. The main objectives of these strategies are to reduce environmental harm, conserve energy, utilize non-renewable resources, and increase safety. Power can be supplied by renewable energy systems to a utility grid or an isolated load. In isolated, off-grid locations, the independent system's applications are more varied.

To address the world's expanding energy needs, research into alternative energy sources has become necessary due to the quick depletion of fossil resources. Another crucial objective for lowering our reliance on non-renewable energy sources is combating global warming. AS a result, alternative energy sources must be discovered in order to meet the ever-increasing energy demand while limiting the negative environmental effects of the same. Due to their ease of availability and topological advantages for local power generation in remote places, solar photovoltaic and wind energy recognized as a capable power generating sources.Due to easy of availability and economic effectiveness, solar PV and wind energy have increased in popularity since the 1970s oil crisis.

The most promising renewable energy technologies are photovoltaic and wind energy systems. A PV array, DC-DC converter, DC-AC inverter, load make up a photovoltaic (PV) system. The creation pf appropriate algorithms to manage the power converter is critical for the PV system’s efficient operation. Wind power is another cost-effective renewable energy source, and in industrialized nations with abundant wind

http://doi.org/10.36893/JNAO.2023.V14I2.320-328

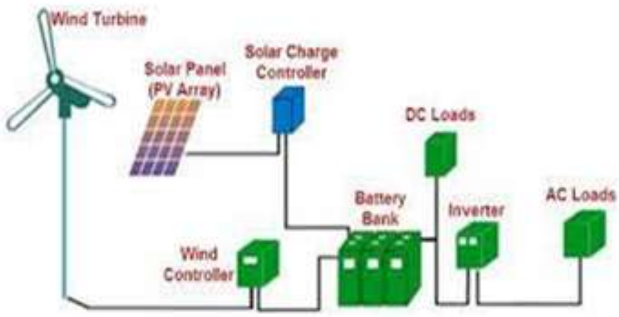
resources,on shore wind often outperforms fossil fuel output. This gives less losses and more efficient energy for remote areas. Most of the places they prefer this hybrid system.

The use of wind power has increased dramatically in recent years. Enormous expansion I the last ten years, and has been, acknowledged as a cost-effective and environmentally sustainable option electric poor generation that is competitive. The wind is blowing. The energy system creates power in the form of alternating current (AC). In the situation of fluctuating voltage and frequency levels operation a high rate. The electricity generated by a solar energy system is in the form of dc voltage, which fluctuates based on temperature and irradiance levels. For grid interconnection, each of these systems require a power electronic interface.

One of the new trends in renewable energy technology is the combination of multiple energy sources and energy storage systems. The best hybrid combination of all renewable energy systems, stand-alone wind with solar photovoltaic, is recognized as the best hybrid combination of all renewable energy systems and is suited for most applications taking into account seasonal fluctuations. During lean periods, they also complement each other; for example, additional wing energy production during monsoon months compensates for lower solar output.In the same way, when the wind isn't blowing, solar photovoltaic (SPV) takes over. Now a days it is mostly used.

This paper presents a hybrid renewable energy system based on solar PV and wind power. Individual DC-DC converters connect the wind and solar systems, which are then connected to the storage battery. The system is simulated and the performance of the system is evaluated using MATLAB/SIMULINK.

2. HYBRID ENERGY MODELING SYSTEM



Hybrid energy system models explains how to model a wide range of hybrid energy system in terms of scale, design, operation, economic dispatch, optimization, and control. As a result, the key problems in hybrid systems are to discover to bestperformance, sizing, and design for an aim of least operational cost, maximum efficiency and reliability, and carbon dioxide emission reduction within predetermined constraints. The study aims to modeling, simulation processes, hybrid power generation future trend development.

Hybrid energy system have gotten lot of attention since they can used in remote areas where grid power isn't available to obtain an efficient energy supply in remote places, several renewable energy technologies such as standalone solar systems are proposed. Expectations for generating power from renewable sources of energy have risen as a result growing awareness of climate change and other environmental challenges. To develop cost -effective and efficient electricity generation solutions. These technologies 'economic characteristics are sufficiently promising to include them in developing poor countries' power generation capacity.

3. MODELING OF VARIOUS RENEWABLE ENERGY SOURCES

http://doi.org/10.36893/JNAO.2023.V14I2.320-328

This represents the models of solar PV, Wind and some electronic devices that are used in this system. Solar panels are base of the any solar photovoltaic system. Solar panels usually positioned on the top and convert sunlight into electricity either by solar cells(PV), indirectly through solar panels, or a mix of the two.

A.MODELING OF PHOTO VOLTAIC SYSTEM

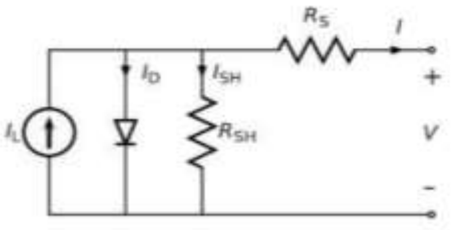


Fig1: Solar PV cell

Solar power works by converting energy from the sun into power. there are two forms of energy generated from sun for our use -electricity and heat.

The equation of output current is

$I = I_{PV} - I_D - I_{SH}$ (1)

Where

$I_D = I_0[exp\frac{V}{AV_T} - 1]$ (2)

Then equation (1) becomes

$I = I_{PV} - I_0\left[exp\frac{V}{AV_T} - 1\right] - I_{SH}$ (3)

The I-V characteristics of a solar cell is given by

$I = [\exp\left(\frac{V+I*R_S}{I_{PV}-I_0*V_T}\right) - 1]$ (4)

$$P = V\{I_{SC} - I_0\left[EXP\left(\frac{V}{AV_T}\right) - 1\right]\}(5)$$

I_{PV} is the current from PV.I_0 is diode reverse saturation current,$V_T = \frac{N_S*K*T}{Q}$ is thermal voltage of PV module. R_S is starting resistance.I_{sc} is the short circuit current, q is electron charge, K= 1.38*10^-23 is the Boltzmann constant; T is the temperature of the p-n junction and A=2 is the diode ideality factor. PV system resembles the nonlinearcurrent voltage (I-V) and Power -voltage(P-V) varies with radiant intensity and cell temperature.

B.MODELING OF WIND TURBINE

A windmill is a structure that uses vanes called sails or blades to convert wind energy into rotational energy. The term is also applied to wind pumps, Wind turbines, and other applications. It consists of two types that are vertical axis and horizontal axis wind turbines depend on their structure.

The power captured is given by

$$P_\omega = \frac{1}{2}C_\rho\, \rho.A.V_\omega\text{^}3$$

The amount torque is given by

http://doi.org/10.36893/JNAO.2023.V14I2.320-328

$$P_\omega = T_{W_{W_\omega}}$$

Where ρ is the air density, which is equal to 1.225 kg/m^3.C_ρ is the power coefficient,V_w is the wind speed in (m/s) and A is area swept by rotor in(m^2). T_w in (N-m) is given by ratio of wind P_ω and rotor turbineW_ω in (rad/sec).

These are installed at mostly rural areas because less power supply and inefficient power. It is desirable to develop an affordable and efficient hybrid controller that would widen the use of resources available while keeping the batteries more consistently charged through two means of harvesting: solar and wind.

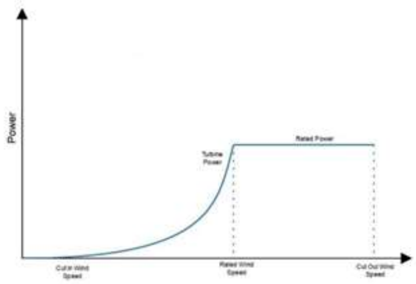


Fig2: Power versus Speed

Wind turbine performance based on the design of the turbine and the wind speed. A turbine will not begin to produce until the rated cut-in wind speed; it is achieved when the rotor's aerodynamic power is greater than the sum of equipment loads and mechanical and electrical efficiencies. Conversely, the cut-out wind speed is when the wind speed blows beyond the limits under which the turbine and generator can function without exceeding structural limitations. Rated wind speed defined as that wind speed at when the turbine is operating at or near its maximum efficiency.

C. BATTERY STORAGE SYSTEM

The battery we used is depend on load that required for our use. The life of battery depend on how we utilize it without giving huge amount of energy to it. The solar battery last for 5to 20 years. Lithium-ion batteries are by far the most popular battery storage option today and control more than 90% of the global grid battery storage. Compared to other battery options, lithium- ion batteries have high energy density and are light weight.

$$v_b = v_a + i_b.r_b - k\frac{Q}{Q + i_b dt} + A.\exp B\int i_b dt$$

Where v_b denotes the battery terminal voltage, v_0 is the open circuit battery voltage,r_b is the battery internal resistance, i_b is the battery charging/discharging current, Q is the battery capacity in Ahr, A is the exponential voltage constant and B is denotes exponential capacity.

D. CHARGE CONTROLLER

A charge controller is required for efficient and safe battery charging. A solar panel and wind are attached directly to the battery may continue to charge until battery suffers internal damage. The voltage and current flow from solar panels to a battery are controller by a solar charge controller. It detects and checks the battery isfully charged, it reduced the current.

To keep the battery ready to use, the circuit provides a balance charge.the output from solar panel and wind is connected so that we can see the required value. So that we can generate dc but if we want we can add inverter to this so that we can convert into AC current to the load otherwise DC.

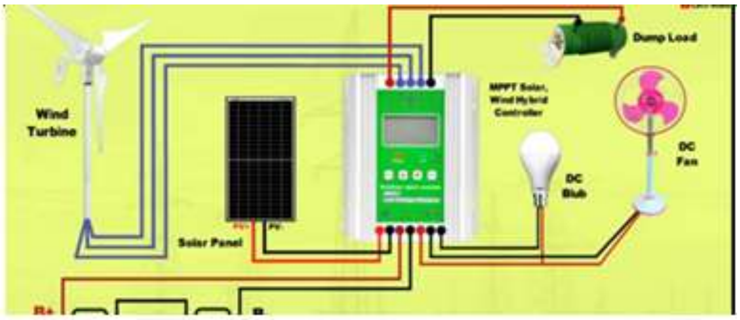


Fig3: Connection Diagram of Charge controller

MATLAB BASED DESIGN OF SOLAR PV SYSTEM

By using Simulation we obtained the solar PV and required tools ae used that are available in MATLAB/SIMULINK software to design the proposed system. In this we will discuss the MATLAB model for solar PV. A. Design of solar PV system by using MATLAB model where solar panel, diode, resistor, voltage and current measurement are used to get the model for solar PV.

The PWM and the MPPT are used to attain the output for solar PV, DC-DC converter, inductance with some value, H-BRIDGE inverter circuit, voltage PI controller in unbalance d-q circuit, inverter output voltage reference generation in unbalance d-q form, perturb and observe MPPT control.

TABLE 1 PV module design

PARAMETERS	**VALUES**
Rated Power of each module	1kw
MaximumPower (Pmax)	10WP
Voltage at Maximum Power (Vmax)	18.02 V
Current at Maximum Power (Imax)	0.55 A
Open Circuit Voltage (Voc)	21.50V
Short Circuit Current (Ioc)	0.57 A
Tolerance	=/- 5%

By using these parameters and its values determines the required components values.Thenweapply in SIMULINK/MATLAB then we obtain the required output.

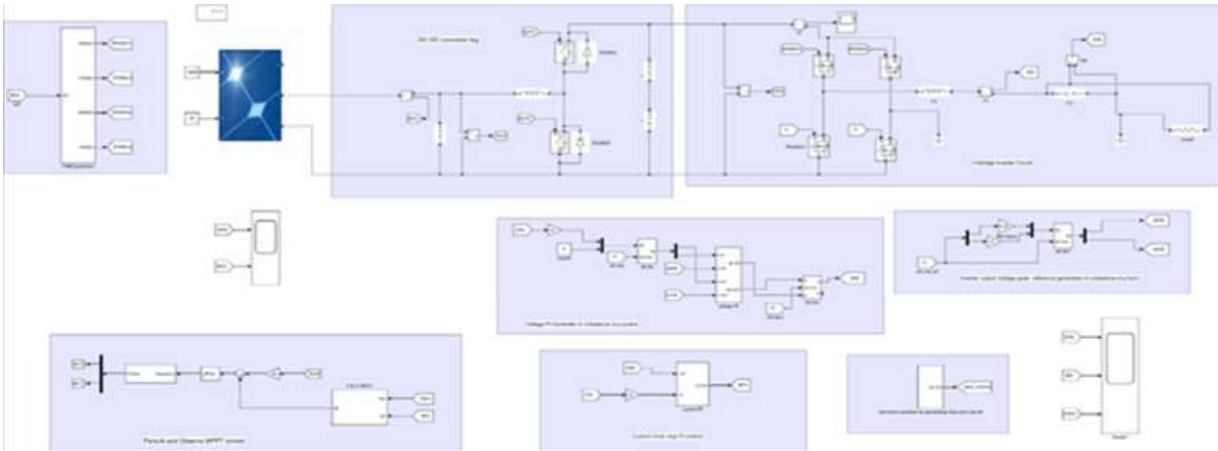


Fig 4: MATLAB based design of PV cell

B. Design of wind system

The wind system consists of two or three blades mechanically coupled to a generator. It takes kinetic energy that available from wind and changes into mechanical rotation of the shaft. Now selecting required tools in MATLAB/SIMULINK and then connected to each to get the required output. In this we use wind turbine and PMSG, universal diode, Three-Phase series RLC Branch, Three-Phase V-I measurement required to obtain the output.

TABLE 2: Wind parameters

PARAMETERS	**VALUES**
Rated Power	20kw
Blade length	3.7m
Number of blades	3
Voltage output	200V
Current output	4A
Rated wind speed	11m/s
Cut in wind speed	2.5m/s
Cut out wind speed	25m/s

By using these parameters and its values determines the required components values. Then we apply in SIMULINK/MATLAB then we obtain the required output.

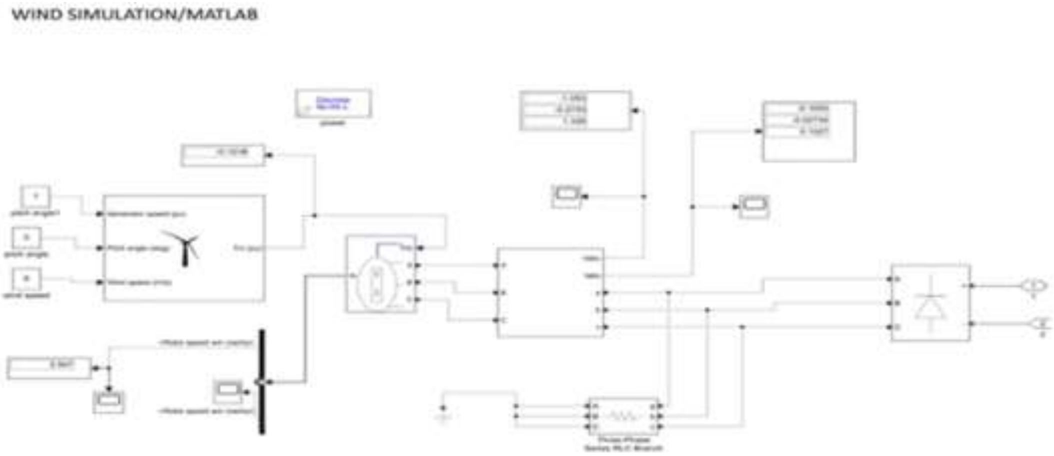


Fig 5: MATLAB based design of wind turbine

4. RESULT AND DISCUSSION

The required outputs are obtained for the Hybrid PV and wind system by using MATLAB/SIMULINK and we can go for HARDWARE implementation so that we get the voltage and current our required areas. In MATLAB/SIMULINK we get the voltage that required to our households.IN all cases, required parameters ranges and namely solar irradiance (Irr), dc-link voltage(Vdc), ac current at the load terminals(Iac) and the power consumed the ac terminals are represented in MATLAB/SIMULINK. As well in HARDWARE we did for DC only so that required output obtained. We can place inverter so that it can changes DC to AC.

Wind output waveforms

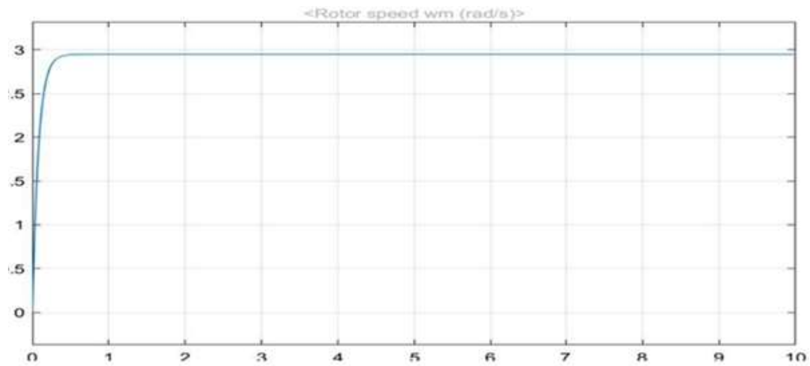


Fig 6: wind voltage versus speed

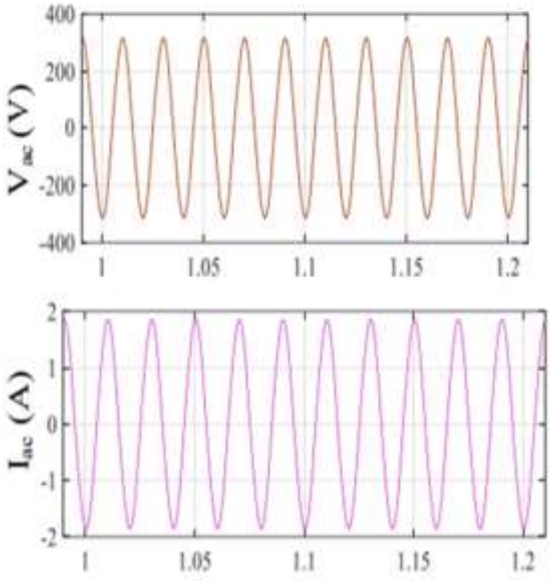


Fig 7: wind current and voltage waveforms

Solar output waveforms

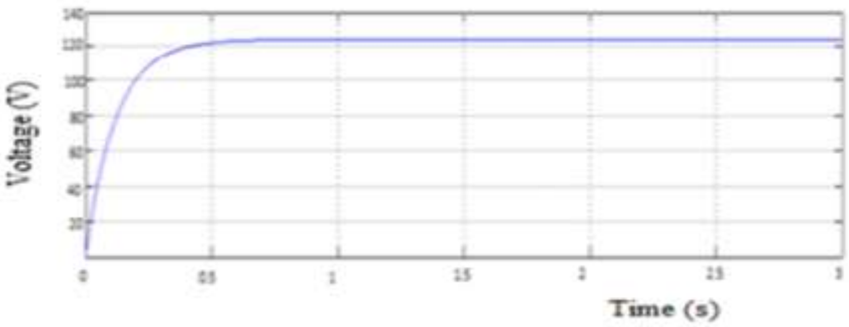


Fig 8: solar voltage output waveform

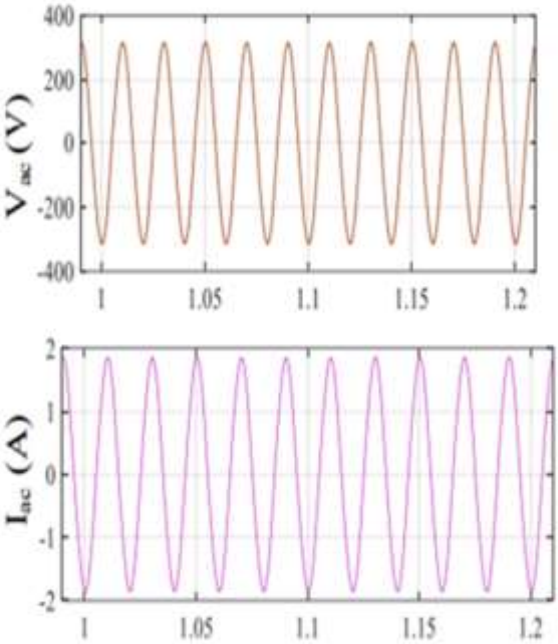


Fig 9: solar voltage and current waveforms

http://doi.org/10.36893/JNAO.2023.V14I2.320-328

CONCLUSION

Grid expansion is currently not a feasible option for reaching the rural population without electricity because the link is neither economically viable nor supported by the important stakeholders. Additionally, due to growing oil prices and the unbearable impacts this energy source has on both customers and the environment, conventional energy sources, such as fuel-based systems, are rapidly being phased out of rural development operations. Infrastructure investments in rural regions must be approached with approaches that are cost-competitive, dependable, and efficient in order to ensure a sustainable access to energy and to foster growth.

Reaching the rural population without electricity by grid extension is now not imaginable because the link is neither economically viable nor supported by the main actors. Additionally, due to growing oil prices and the unbearable impacts this energy source has on both customers and the environment, conventional energy sources, such as fuel-based systems, are rapidly being phased out of rural development operations. Infrastructure investments in rural areas must be handled with approaches that are cost-competitive, dependable, and efficient in order to ensure a sustainable access to energy and to foster growth.

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