

An Overview of Hybrid Renewable Energy Systems

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Abstract

Long-term evaluation and analysis of several factors should be done to propose a full-phase power generation system based on renewable energy sources. An accurate assessment of the potentially available resources should be done like measuring solar irradiation, wind speed, etc. We are designing a hybrid system where hybridization methods entirely consist of renewable energy sources—specifically solar photovoltaic (PV), wind, and gravity systems. Wind and solar are among the popular renewable resources used all over the world. The systems installed for village electrification in the village school of load 60-watt DC LOAD, it is a further hybrid with coupling system and wind power harnessing system. This paper presents a new method for connecting renewable energy sources.

Keywords: Renewable energy, hybrid energy, solar, wind, gravity, battery, DC load

INTRODUCTION

A large percentage of the global population mostly resides in remote rural areas, and governments often cannot provide basic energy facilities for these sparsely populated regions. Thus, systems are often the only way to meet the energy needs of the population in remote places. Many remote systems, such as repeater tower stations and radio telecommunication stations, are entirely dependent on an off-grid system. The rapid depletion of fossil fuels throughout the world has also made it necessary to reduce dependency on these non-renewable energy resources. One way of accomplishing this is to exploit the enormous potential of renewable energy sources to meet continually increasing demands for energy-dependent on off-grid power systems [1, 2, 3].

The term hybrid power system allows any power system to combines two or more energy and fuels for a device, that exceeds the when integrated. The design and structure of a hybrid power system take into account the types of locally available renewable energy resources and the consumption supported by the system. For example, the hybrid energy system presented here is a small-scale system and the utilization of power takes place during the required time. *Village School Load Can be Considered as of 60 watts After Load Assessment* [1, 4, 5].

To improve the reliability and power quality of renewable energy (RE) based systems, energy storage devices, and conventional generators are commonly used as backup systems.

However, distributed generation using two or more renewable energy sources can also significantly increase reliability. Hybrid renewal energy systems (HRES) include PV–battery, PV–diesel, wind–diesel, PV–wind–battery, and PV–wind–diesel–battery systems.

In the case of PV and wind power systems, long-term solar irradiance and wind speed data are required to improve predictions about energy output (Figure 1). The available energy discrepancy between and wind systems necessitates the use of battery banks with adequate capacity to satisfy the demand for electricity [1, 2, 4].

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Received Date: May 13, 2021
Accepted Date: May 27, 2021
Published Date: May 31, 2021

Citation: Udit Sahai. An Overview of Hybrid Renewable Energy Systems (HRES). Journal of Alternate Energy Sources & Technologies. 2021; 12(1): 21–26p.

Hybrid systems may face limitations in terms of fuel flexibility, efficiency, reliability, etc. They incorporate heat, power, and highly efficient devices (fuel cells, advanced materials, cooling systems, etc.) that can increase overall efficiency. In comparison to other individual technologies energy in a hybrid system is more conserved. Achieving higher reliability can be accomplished with energy storage equipment (Table 1).

Table 1. Component specification.

S.N.	Components	Voltage	Current	Components type
1	Generator specification	DC 6-38 volt output power	Max load current 1 A	Permanent Magnet DC Motor
2	Gear specifications			Spur gears helical gear
3	Load toward the gravity using plastic bottle as per as requirement			
4	Solar plate specifications	Plate o/p voltage 12volt	Max output current 0.8A	Poly crystalline plate
5	Battery specifications	Output voltage 12Volt	Output current 15 AH	Lead-acid battery
6	Voltage regulator specification			The voltage regulator IC 7812
7	Load (DC)			60 watt

System Specification

PV wind hybrid power system: In PV system design, it is essential to know the amount of solar radiation available at a particular location at a given time. The solar irradiation varies throughout the day (Figure 2). The power system has a battery bank capacity of 12 volt and 150 Ah [1, 6, 7].

Hybridization of PV wind system with gravity system generator and Wind generator are hybridized with gravity system (Figure 3). Since both PV generator and wind generator will produce output so they can be easily fed to the storage battery.

METHODOLOGY

Various assessments should be done before proposing a hybrid system. These should include as follows.

- i. *Demand Assessment:* Using accurate load forecasting of remote villages, the load demand can be fetched.
- ii. *Barriers/Constraints:*
 - Annual electricity demand,
 - Reliability
 - Net Present cost,
 - Environmental factors,
- iii. *Demand assessment:* It is fulfilled by Hybrid Renewable Energy System (HRES). This can be done by combining one or more renewable energy sources with conventional energy sources such as wind, solar, etc. Some hybrid renewable system configurations are as follows:
 - PV/wind/diesel generator HRES
 - PV/wind/fuel cell HRES
 - Wind/battery HRES
 - Biomass/wind/diesel generator HRES
 - PV/wind/biomass/fuel cell HRES [8, 9, 10]

HYBRID SYSTEM OPTIMIZATIONS

Power Reliability Analysis

Power reliability plays an important step in the design process of the hybrid system. The hybrid energy system must satisfy the load in an economically and cost-efficient way. There are many methods used to calculate the reliability of the hybrid system:

- i. Loss of power supply probability (LPSP)
- ii. Loss of load probability (LOLP)
- iii. System performance level (SPL)
- iv. Loss of load hours (LOLH) [8, 10, 11].

System Cost Analysis

There are several economic criteria for the system cost analysis, such as net present cost, leveled Cost of energy, and life-cycle cost. The net cost is defined as the total value which includes the initial cost of all the system equipment, the cost of replacement of any component that occurs within the lifetime of the project, and the cost of maintenance. The lifespan of PV modules is generally considered as the life of the system [12, 13].

STORAGE MANAGEMENT

Energy storage is critically important for ensuring a continuous supply of power to the load, such as lead acid battery.

Lead storage battery requires low maintenance and comes in all shape and sizes which makes it convenient for use. High discharging time makes it useful in terms of reliability and working capabilities.

CALCULATIONS

Output Power from PV Generator

- Poly Crystalline Plate
- Plate o/p voltage 12 volt
- Max output current 1 Ampere
- Out power 10 watt

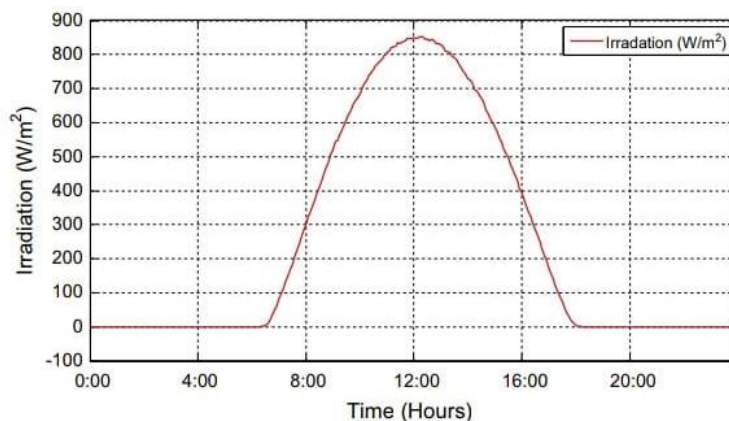


Figure 2. Power waveform PV generator.

Output Power from Wind Generators

Let

m = mass of the air (kg)

v = the velocity of air in m/s.

So kinetic energy

$$E = m u^2 / 2 \quad (1)$$

Power output

$$P = \rho \times (v^3) / 2 \times A \quad (2)$$

The limitation of the speed of winds at least 16 km/h.

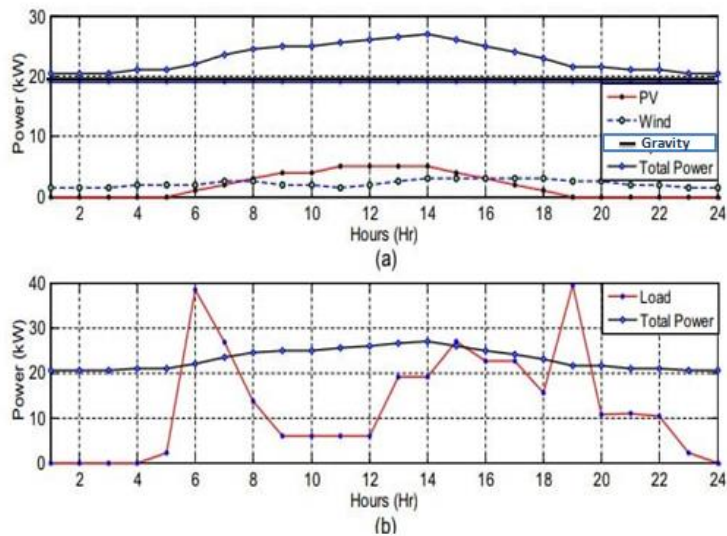


Figure 1. Power waveform of the hybrid system.

CAPACITY BATTERY CALCULATION

Output voltage = 12 volt

Current rating = 15 AH

Discharging current = Watt/Voltage

We can assume 60 watt load

$$60/12$$

Discharging current 5A

Backup hour

Backup hour/discharging current

$$15 \text{ Ah}/5\text{A} = 3 \text{ hr.}$$

3-hour 00.0 min.

All number are considered in case of DC power.

The backup hour increases and decrease depending upon battery rating.

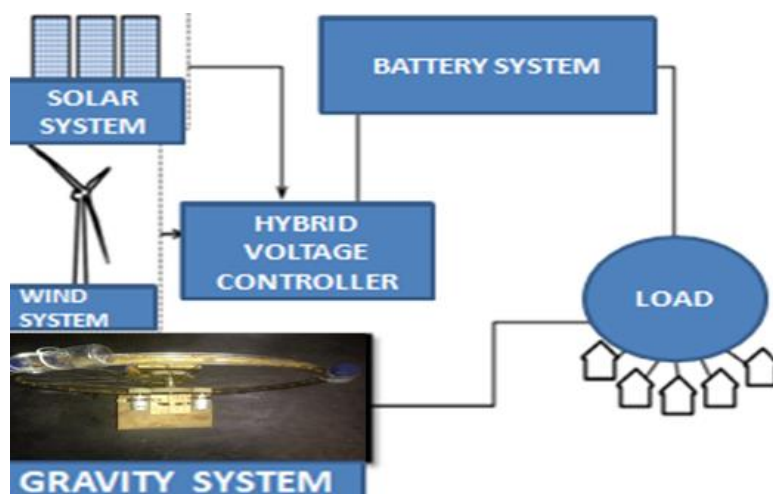


Figure 3. Block diagram of our proposed system.

FUTURE TRENDS AND LIMITATIONS

Following are the challenges faced by the designer.

- i. Renewable energy sources, such as solar PVs, need innovative technology to harness more amount of useful power from them. The low efficiency of solar energy generation is one of the major obstructions in promoting its use.
- ii. The manufacturing cost of renewable energy sources needs significant reductions.
- iii. It should be ensured that there should be a minimal amount of power loss in the power electronic devices.
- iv. The storage technologies need to increase their life-cycle through inventive technologies.
- v. These standalone systems are less adaptable to load fluctuations. Large variation in load might even lead to entire system collapse [8, 13, 14].

CONCLUSION

This paper gives an overview of hybrid renewable energy system's reliability which can be improved by the integration and optimization of essential equipment such as energy resources, energy storage, and energy management. Hybrid energy renewable systems are economical, less or no fossil fuel consumption, and have no or less greenhouse gas emission.

For remote areas, energy sources are limited and less dependent, in villages and their school's electricity remains only for a short period therefore by using this hybrid system to generate electricity in areas are much more efficient.

Acknowledgment

I would like to express special thanks to my project guide the Assistant Professor Mr. Raghvendra Pratap Singh. Mentor the Associate Professor Ms. Kitty Tripathi as well as the Head of Department of Electrical Engineering, and the Associate Professor Mr. Rituraj Jalan for this golden opportunity to deep study and analysis on the thesis hybrid renewal energy systems (HRES). I came to know so many things because choosing that wonderful thesis secondary I would like to thank my parent's brother and friend who help me finalizing the topic within the limited frame of time under such an extreme covid situation

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