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A Hybrid Wind and Hydroelectric Power Production System

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ABSTRACT

The purpose (main purpose) of this paper is to study the feasibility of electrification without grid in the Indian subcontinent. The electrical installation will be done with a mixed system that includes Small Hydropower using compensation for water flow, and wind power. Given the climate change that has been observed in regions around the world and believed to be due to the use of conventional energy sources, we must turn our attention to renewable energy sources that are conducive to the future. This paper presents research on the design and simulation of small wind hydro power. After execution, this experimental station will be used primarily to study the potential for hydropower plants to conserve wind power through hydro energy.

KEYWORDS: *Hybrid power systems, Micro hydro power, Wind energy generation*

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INTRODUCTION

Hydropower is one of the sources of renewable energy sources where energy is available from falling and flowing water. Since ancient times, hydropower has been used for irrigation and the operation of various machines, such as watermills, sawmill textile mills, power houses, and others [1]. The process of using electrical energy consists of different electromechanical elements and social structures. The water accumulates in the reservoir with the help of a dam and passes through a pumping station and continues through the penstock (which may also have holes) to the hydraulic engine where power exploitation is carried out [2]. The following figure shows a typical electric power diagram showing the main components of hydroelectric power plants.

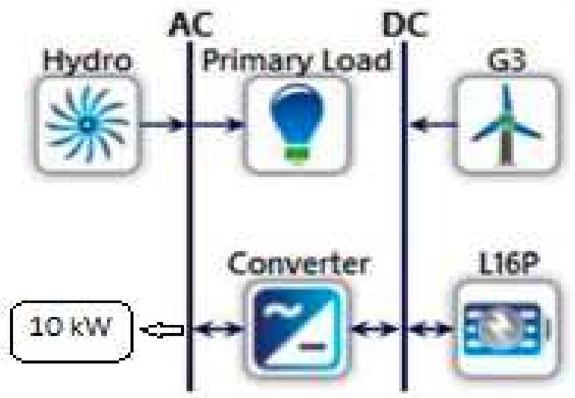

Fig 1 Simplified diagram of the hydro–wind hybrid power system

Hydropower plants are powered by water from a dam. If there is more power, the hydro power station will act as a larger battery by returning water to the top of the hill and returning to the water storage area. In this way, hydroelectric industries can generate electricity when prices are high and use electricity when prices are low, grid-connected as well as wind turbines. Due to the concurrent roles of wind and hydro turbines, hybrid systems can continue to generate energy at high cost. This system is well suited to rural areas where access to electricity is not available, especially for irrigation purposes [3]. Fig -1 represent the Simplified diagram of the hydro–wind hybrid power system.

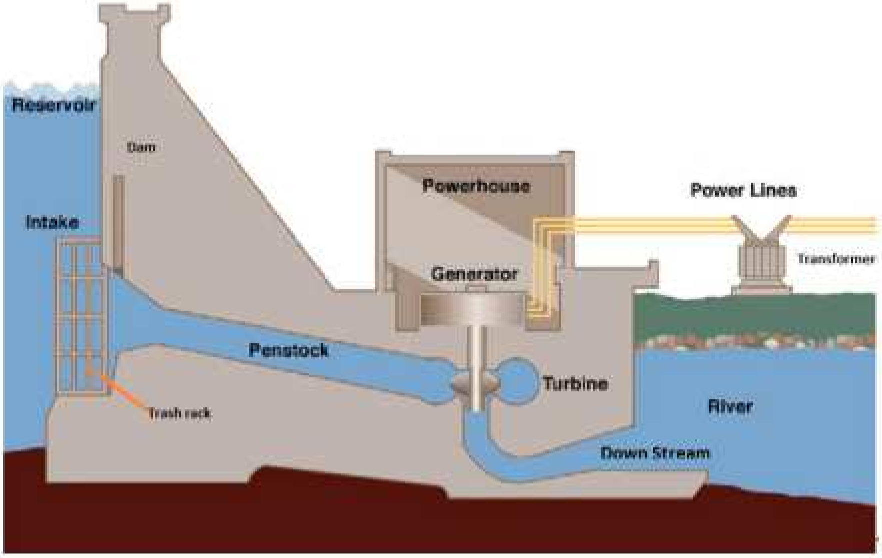

Fig-2 Generalized Hydropower Schematic Diagram

Modeling of hydro power:

The theoretical power available from hydropower can be calculated from the flow rate and density of water, net head, and local acceleration due to gravity[4]. The Generalized Hydropower Schematic Diagram has been shown in fig- 2

$$P_h = \eta_{TG} * \rho * g * Q * H_{net} \quad (1)$$

P is the hydro power in watt

η_{TG}= is the efficiency of turbine and generator

Q is the density of water

g is the acceleration due to gravity

H_{net} Net head in meter

The aim of this research paper is to design a A hybrid wind and hydroelectric power production system to generate electricity based on green energy sources while ensuring energy availability throughout the year[5]. System

- Environmentally friendly;
- Efficient enough for feeding the load;
- Applying sustainable and renewable energy sources; and
- No environmental effects.

Governor

The controller is an important factor required for the reliable operation of the hydro turbine generator system. There are three main repair modes, which include frequency correction mode, open correction mode and power correction mode. In this design, a PID control (proportional-integral-derivative) is considered and the control region is shown in Figure 3 [6].

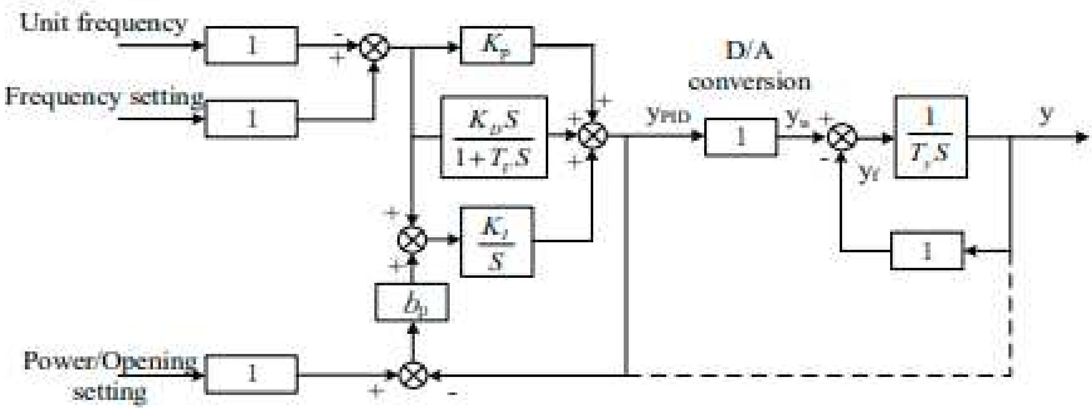

Figure 3 PID controller for the governor

Modeling of wind turbine:

Wind power is a source of renewable energy. Wind turbines are used to convert wind kinetic energy into electricity. A generator connected to the blade shaft converts mechanical power into electrical power. Depending on the rotation axis of the blades, there are two types of wind turbines. The first are axis wind turbines horizontal and horizontal wind turbines. The power of the turbine depends on the wind speed. The power generated by the turbine varies. For continuous power, electricity is first stored on the battery and then brought to charging[7].

The permanent magnet synchronous generator converts mechanical energy produced by wind turbines into electrical energy. These energies are later fed into the grid or collected using electronic devices[8].

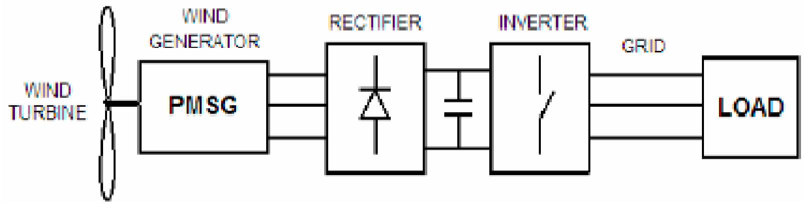

Fig-4 Basic Diagram of a Wind Energy Conversion System

The wind turbine slows down the wind from V to V0 when the wind passes over it and the power extracted by the wind turbine is the kinetic power (kinetic energy per second) differences between the upstream and the downstream as shown in the equation below[9]. Fig -4 represent the basic diagram of wind energy conversion system.

$$P_{mech} = \frac{1}{2} \text{m} \left(V^2 - V_0^{\,2}\right) \qquad (2)$$

P_{mech}= Mechanical power extracted by wind turbine in watt

M is mass flow rate of the air in kg/s

V= Upstream wind speed at the entrance of the rotor blade (m/s)

V_0 is Downstream wind speed at the exit of the rotor blade in m/s

The mass flow rate of the air m will be replaced with

$$\text{m} = \rho A \frac{(V+V_0)}{2}$$

ρ is air density in Kg/m^3 and A is the swept are by the rotor blade in m^2

$$P_{mech} = \frac{1}{2} \rho A \frac{(V+V_0)}{2} \left(V^2 - V_0^{\,2}\right) \qquad (3)$$

$$= \frac{1}{2} \rho A \, V^3 C_p$$

$$C_p = \frac{1+\frac{V_0}{V}\left(1-\frac{V_0^{\,2}}{V^2}\right)}{2} = \frac{\text{The extracted power by the wind turbine}}{\text{Power potential of the wind}} \qquad (4)$$

The factor Cp is called the power coefficient of the rotor or the rotor efficiency

$$\rho = \rho_0 - (1.194 * 10^{-4}) \text{ H}$$

Where ρ_0 is the air density at sea level (1.225 kg/m^3) and H is altitude of the place.

Result: Figs 5 and 6 show the inverted current inverted voltage respectively drawn by the load at the inverter end. Grid frequency has been shown in fig. 7, the frequency varies from 50.655 to 50.625 Hz which shows the stable behavior of the hybrid systems.

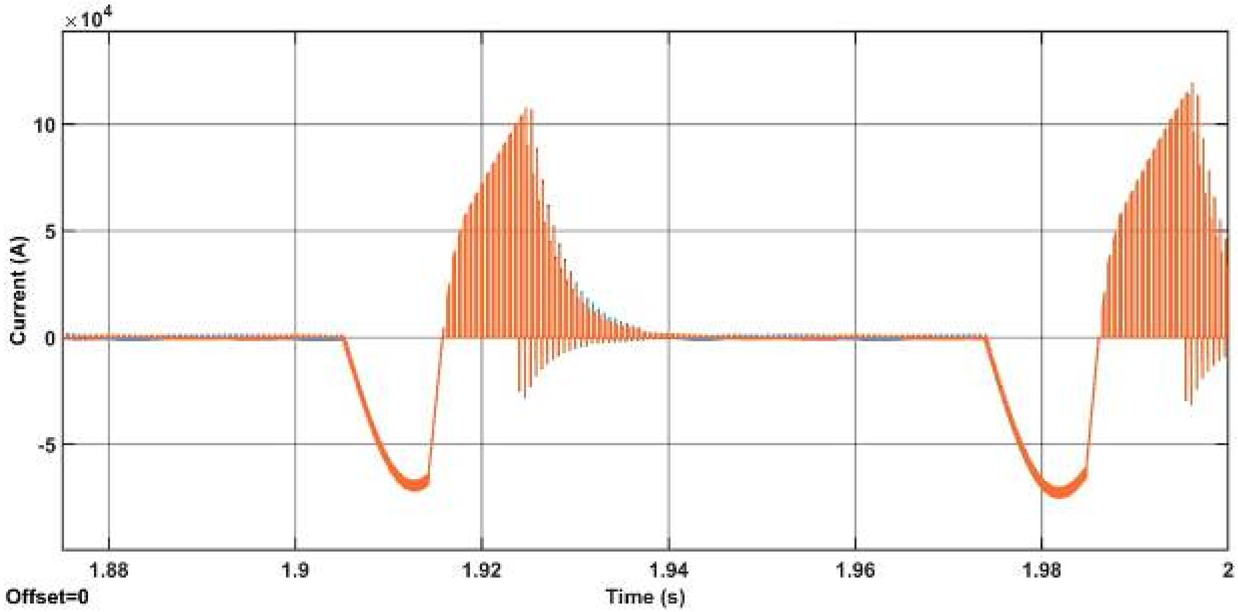

Fig- 5 Three Phase inverted current

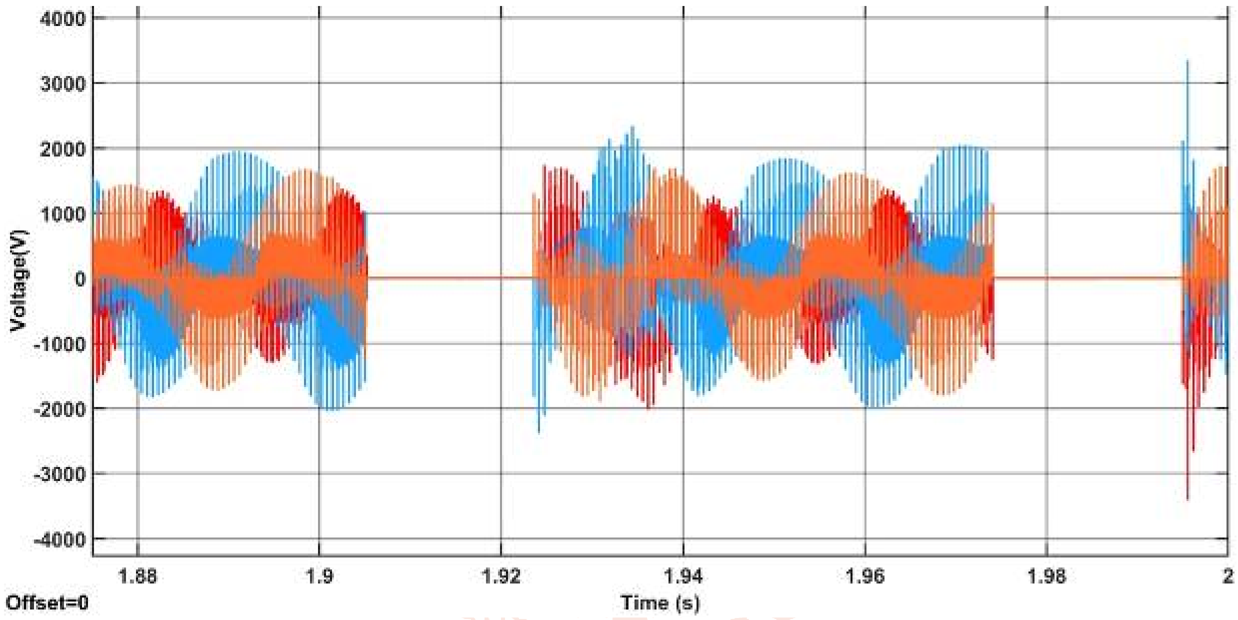

Fig-6 Three phase inverted voltage

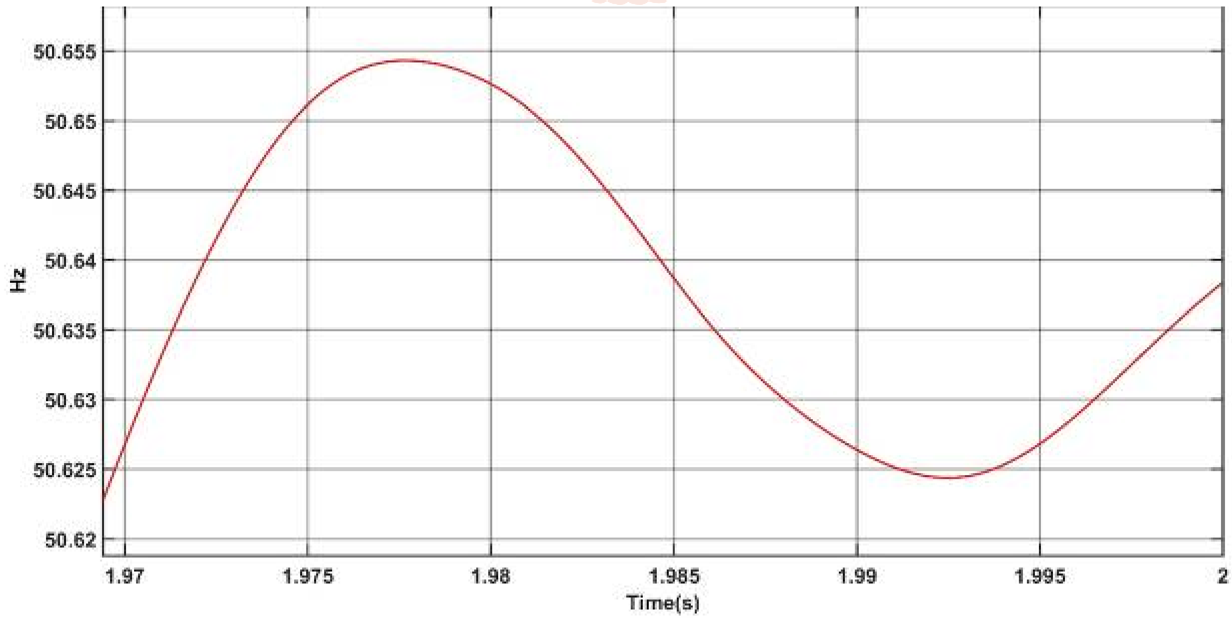

Fig- 7 Grid Frequency

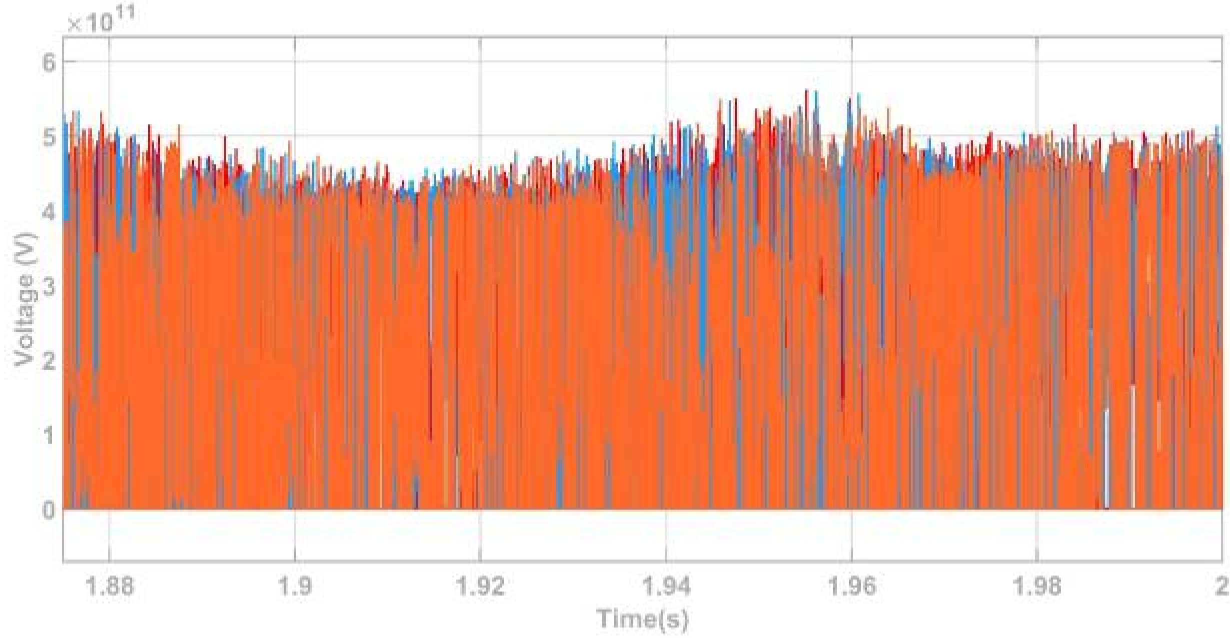

Fig- 8 Voltage generated by hydropower plant

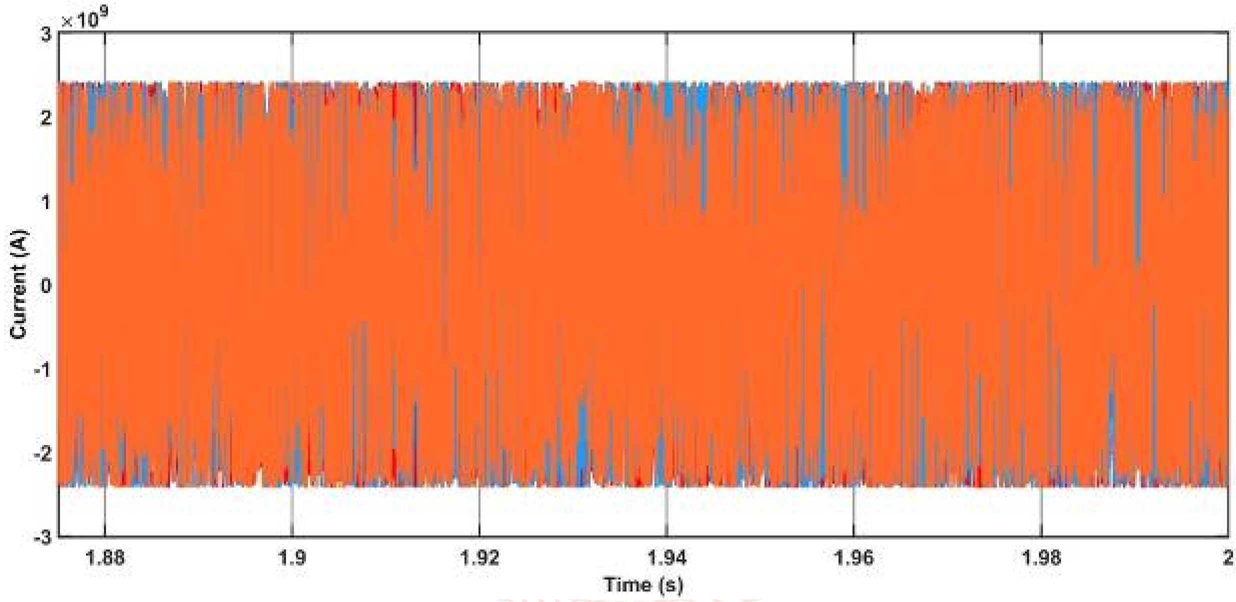

Fig-9 Current drawn by hydropower plant

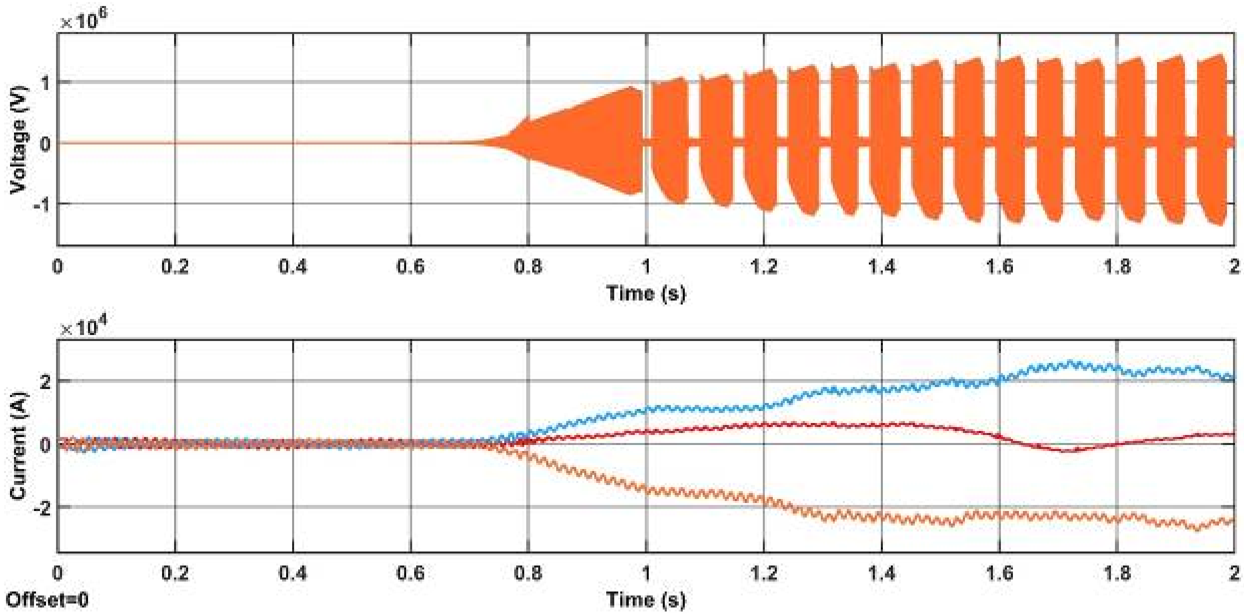

Fig- 10 Voltage generated by wind power plant and Current drawn by wind power plant

Conclusion:

This paper contributes to the literature by focusing on renewable energy generators and the benefits of integrating these resources. The advanced system can be useful for many engineers working in their future studies and work on building hybrid power generators such as wind – hydro energy systems while ensuring that you are able to supply the load demand in the study area. Under current conditions wind turbines are one of the best ways to generate energy. Wind energy is a renewable resource, which means that using it will not deplete the earth's fossil fuels. It is also a source of pure energy, and its efficiency does not emit carbon dioxide, mercury, particles, or any other form of air pollution, as do conventional petroleum sources. Unlike fossil fuels or nuclear power plants, which use large amounts of water to cool themselves, wind turbines do not need water to generate electricity. Therefore, wind power will help conserve natural resources, reduce land pollution and solve energy problems in developing countries like India by installing small wind turbines in colonies, communities, apartments, gardens, etc. Turn off the electricity and remove the burden of energy consumption from resources.

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