Hybrid Wind and Solar Power Generation System

Shreya Gupta[1], Dr. Ankit Shah[2]

[1] *Research Scholar, Instrumentation & Control Dept., L.D. College of Engineering, Ahmedabad, Gujarat, India*

[2] *Assistant Professor, Instrumentation & Control Dept., L.D. College of Engineering, Ahmedabad, Gujarat, India*

ABSTRACT

Exploitation of renewable energy sources for power generation has been more and more important in recent years. This results from the economic issues and the measures taken to ensure energy security. Hybrid systems are more likely to produce dependable power that meets demand. The hybrid combination of both distributed energy resources eliminates mutual intermittences because of their adverse nature; therefore, the reliability of the system will be improved. The basic objective of this project is to generate electrical energy by using renewable and clean energy with minimal pollution. We use a hybrid system to overcome the drawbacks of the renewable freestanding generation system. The working model of the solar-wind hybrid energy generation system successfully operated. By considering the cost and effectiveness of the system, it is suggested that all members of the rural community use the solar-wind hybrid system for the generation of electricity. The study concludes with the outcomes obtained that signify the potential for hybrid renewable energy systems to not only meet but exceed future energy demands sustainably, provided there is concerted effort in research, investment, and policy-making. This paper describes a solar-wind hybrid system for supplying electricity to a power grid and discusses the technical challenges associated with HRES as well as the scope of future advances and research on HRES. The present work explains solar power, wind power, and hybrid solar-wind power harvesting in detail with hybrid power generation perspective.

Keywords: *Solar energy, Wind energy, PV cells, Renewable energy, Hybrid Power System, Battery, etc.*

Introduction:

Renewable energy sources have received greater attention during the past few decades, and considerable efforts have been made to develop an efficient renewable energy conversion system. The major goals of these approaches are to reduce environmental damage, conserve energy, exhaustible sources, and increase safety. Renewable energy systems can supply power either directly to a utility grid or to an isolated load. Wind power generation has experienced a tremendous growth in the past decade, and has been to recognize as an environmental friendly and economically competitive means of electric power generation. The wind energy system generates power as AC with different voltage and frequency levels with variable speed operation. Solar energy system generates power as DC voltage, the level of which varies depending on temperature and irradiation levels. Both of these systems require a power electronic interface for interconnection with the grid. Integrating different energy sources and energy storage systems has been one of the new trends in renewable energy technology. Stand-alone wind with solar photovoltaic is known as the best hybrid combination of all renewable energy systems is suitable for most of the applications that take care of seasonal changes.

They also complement each other during lean periods. For example, additional energy production by wind during monsoon months compensates for less output generated by solar. Similarly, in the post-winter months, when the

Wind is dull, solar photovoltaic (SPV) takes over. Renewable energy systems are likely to become widespread in the future because of adverse environmental impacts and the escalation in energy costs linked to the exercise of established energy sources. Solar and wind energy resources are alternatives to each other and which will have the actual potential to satisfy the load dilemma. However, such solutions, even when researched independently, are not entirely trustworthy because of their unstable nature. In this context, autonomous photovoltaic and wind hybrid energy systems have been found to be more economically viable alternatives to fulfil the energy demands of many isolated consumers worldwide. A hybrid renewable energy system is environmentally friendly because it does not produce harmful gases such as carbon dioxide, unburned hydrocarbons, sulphur dioxide, and nitrogen

oxides. The aim of this paper is to give an idea of hybrid system configuration, modelling, and renewable energy sources. Wind-solar hybrid systems can produce more power that is consistent because solar power is produced during the day, while wind power is typically strongest at night. This inherent complementary nature of wind and solar power makes hybrid systems well suited to meet energy demand, according to the report.

Block Diagram of a Typical PV-Wind Hybrid System

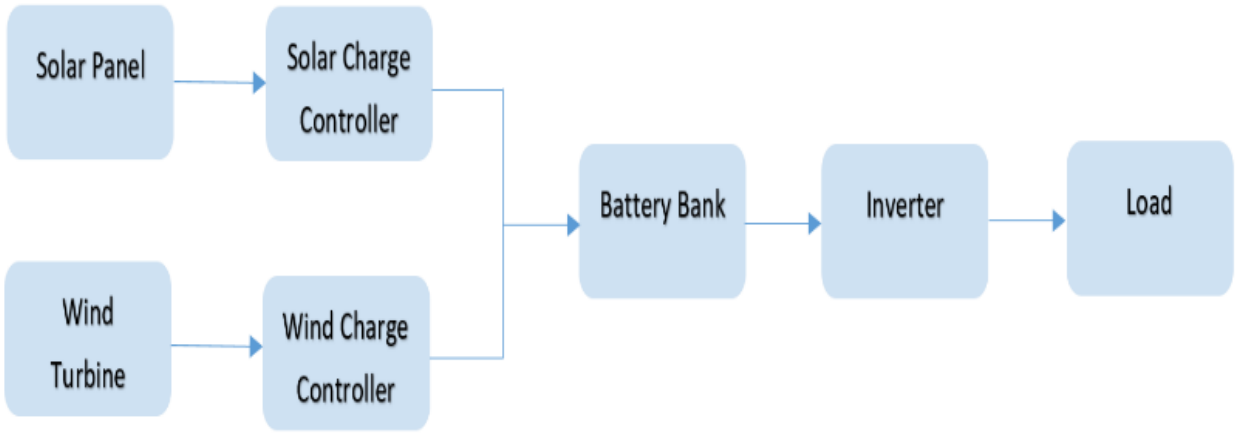

Fig -1: Solar-Wind Hybrid System

Description of a hybrid renewable energy system

This block diagram includes the following blocks: Solar panel, wind turbine, control panel, battery Bank, and inverter. The figure gives an overall idea of the hybrid system. A hybrid renewable PV-wind energy system is a combination of solar PV, wind turbine, inverter, battery, and other addition components. A number of models are available in the literature of PV-wind combination as a PV hybrid system, wind hybrid system, and PV-wind hybrid system, which are employed to satisfy the load demand. Once the power resources (solar and wind flow energy) are sufficient, excess generated power is fed to the battery until it is fully charged. This connection to all the equipment should be carefully analyzed. This combination is a hybrid energy system. Power generation from solar panels and wind turbines complements each other. Either solar or wind energy cannot and does not generate electricity continuously all year round. The operation of a hybrid PV-wind system depends on the individual elements. In order to evaluate the maximum output from each component, first the single component is modeled, thereafter their combination can be evaluated to meet the required dependability.

Solar Panel Energy Calculations:

- Capacity of Unit: 10 W/h Volts: 12V Period for which Solar Panel is exposed to Sun in summer.
- (Ts): 9 hrs Period for which Solar Panel is exposed to Sun in Winter
- (Tw): 7hrs Total Power per Day (Ps): 90W /day.

If Losses are included,

- (The rated power of Solar Panel* the no. of hrs of Sunshine* Dust, Weak Radiation * Efficiency of Charge Controller) (1)
- Power (Ps)= 10*9*0.90*0.85= 64.8Watts/Day
- The power generated by the solar unit (including losses) lies within the range of the power that has been obtained in the calculations. Power generated is different for each hour. It depends upon the time of the day and the solar irradiance at that particular time.

Wind Power Generation Unit Calculations:

Kinetic Energy of Wind: P=1/2*ρ*A*V3

- P=Power, ρ=density, A= swift area, V= velocity of wind)
- p = 1/2 * 1 *0.04575 * 53 = 3.21 kg m2 /s3

Multimeter Reading:

- I = 0.2 amps/min Power (P) = V*I =12*0.2
- Power (P) =2.4 W/min (if Wind Flow is continuous and V =5 m/s).

Policy Analysis: The Ministry of New and Renewable Energy (MNRE) adopted the National Wind Solar Hybrid Policy on May 14, 2018. The objective of the policy is to provide a framework for the promotion of large grid-connected wind-solar PV hybrid systems for efficient utilisation of transmission infrastructure and land. It also aims to reduce renewable power generation variability and achieve better grid stability [5].

National Wind-Solar Hybrid Policy 2018: The policy seeks to promote new hybrid projects as well as hybridization of existing wind and solar projects. The existing wind/solar projects can be hybridised with a higher transmission capacity than the sanctioned transmission capacity, subject to the availability of margins in the existing transmission capacity [5].

- **Integration:** On the technology front, the policy provides for integration of both the energy sources i.e. wind and solar at alternating current (AC) as well as direct current (DC) level.
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- **RPO fulfilment:** Power purchased from hybrid projects is eligible for fulfilment of RPO obligations depending on the proportion of wind and solar-rated capacity.

Capacity Addition in Next 3 Years: 148.8 MW of wind-solar hybrid capacity has been commissioned to date. In April 2018, Hero Future Energies developed India's first wind-solar hybrid project, including 50 MW of wind and 28.8 MW of solar, on a pilot scale. In June 2020, Continuum Wind Energy installed a 55 MW hybrid plant in Periyapatti, Tamil Nadu. As per the tenders allotted under various central and state schemes, the capacity addition of such projects is expected to grow at a CAGR of 223% to reach about 11.6 GW in the next three years. The likely capacity addition is provided in the figure below [5].

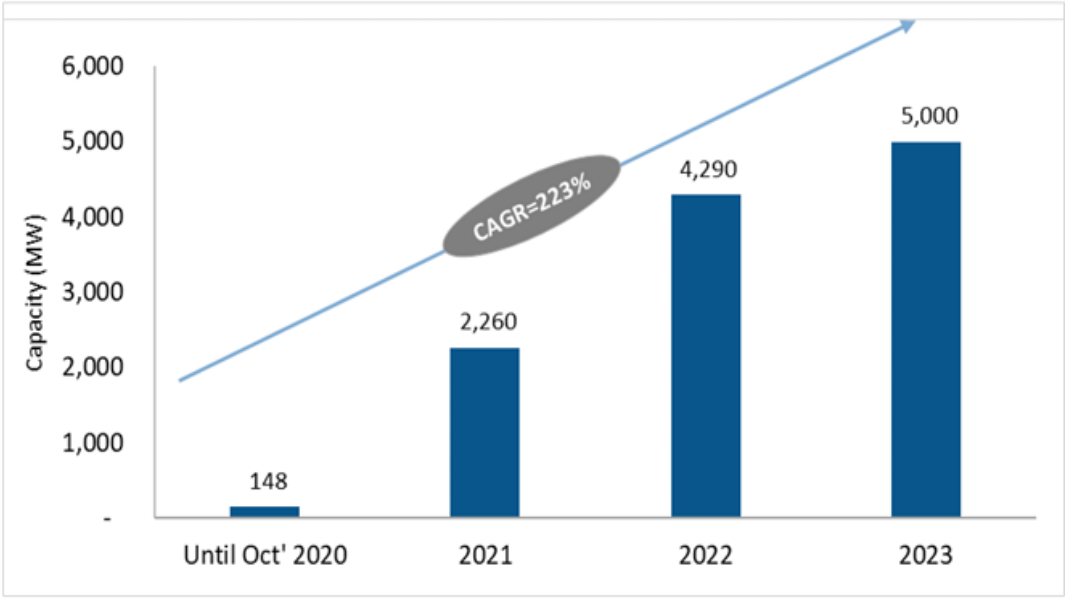

Chart -1: Wind-Solar Hybrid Annual Capacity Addition 2020-2023

Financial Evaluation: The financial feasibility of the project was examined using the simple payback method, in which the payback period was the time it takes for the return on the investment to re-pay the sum of the original investment. The original investment in this context is the sum of all investments associated with the purchase and installation of a wind-solar hybrid system. The return is the income generated. The government should step in to develop plans, collect data, and then conduct competitive bidding.

The hybrid model gave a simple recovery period of no more than 2.6 years. The hybrid power plant has been generating 12 units of electricity per day on an average basis and sometimes when the wind velocity is high, the power generated is about 30 units per day. The average cost of generation power in this mode comes out to be about Rs. 15/-per unit. The plant has generated about 2865 units of electricity in one year. The villagers are contributing Rs.50/- per month towards energy charges and are enjoying 24x7 electricity. The power availability in these villages has increased from about 50% to 100%. i.e., form 7-12 hours in the pre project scenario to 24 hours in the post project period. The project has been an exciting learning experience for HAREDA while successfully demonstrating solar wind hybrid power generation technology on the ground.

Advantages of Hybrid Solar Energy Systems:

- **Low Maintenance Cost:** This system is cost-effective in the end. Although the initial cost may be high, you will eventually save money because you will not have to pay for fuel (like with generators), and these systems do not require frequent maintenance.
- **Load Management:** Hybrid solar power systems store energy during the day and distribute it at night. A hybrid solar system may have technology that automatically adjusts the energy supply according to the power requirements of specific devices, whether it is an air conditioner or a fan
- **Utilized the renewable sources in the best way:** Batteries are connected to a specially designed system that stores excess solar energy, so there is no waste of unused power. Therefore, these systems make use of the renewable energy in the best way, storing energy on sunny days and utilizing that stored power on cloudy days or night.

Disadvantages of Hybrid Solar Energy Systems:

- **Less Battery Life:** Home batteries connected to the system are often exposed to heat, cold, or rain, so the system may have a shorter life span.
- **Complicated Controlling Process:** Different sources of energy are used; it is helpful to be knowledgeable about those systems. The operation of different energy sources and the interaction between them can be complicated.
- **High Installation Costs:** While the maintenance cost is low, the initial investment for a hybrid solar energy system is higher compared to solar systems alone.

Future Trends in Hybrid Wind-Solar Energy systems:

- In the future, operators would like RE plants to have the ability to operate more like traditional power plants in terms of capacity value, dispatch ability, and reliability.
- As a result, HRES will be more cost-effective in the future. Apart from the expense, the environmental advantages are likely to make this hybrid system more widely used and accepted.
- Evaluate HRES-specific design challenges and opportunities, e.g., economies of scale and technological innovation.
- There should be a minimal amount of power loss in the power electronic devices while interfacing the HRES to the utility.

Results and Conclusion: Development and utilization of renewable energy, such as wind, PV, hydropower, is an effective way to solve the energy crisis and environmental pollution problems. However, there are some drawbacks, mainly due to fluctuations in wind and solar energy. Especially the wind energy has a great influence on the stability of the grid. The hybrid system will bring enormous benefit to the rural and remote areas of India, where there is a severe crisis of reliable electricity supply. The system will reduce CO2 emissions by several percentages, thus bringing local as well as global carbon benefits. The role of renewable energy has therefore become more significant. The developed world is already on track to reduce fossil fuel usage and develop renewable energy technologies. The system is designed and optimized as a hybrid energy-based power system in parliamentary procedure to meet the existing user's power requirements at a minimum price of energy. This paper also highlights future developments that have the potential to increase the economic attractiveness of such systems and their acceptance by the user. Through this project, many villages can be lit. For villages that are far away from the construction sites of large power-generating stations such as hydroelectric and nuclear, power can be provided.

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