DESIN AND APPLICATION OF EV CHARGING STATIONS RUNING BY WIND – SOLAR HYBRID SYSTEM IN INDIA

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Abstract - It is essential to shift to sustainable transportation infrastructure in order to lessen the negative environmental effects of using fossil fuels. Though they provide a potential answer, the lack of proper infrastructure for charging electric cars (EVs) is impeding their wider adoption, especially in places like India. This study suggests a creative solution to this problem: creating and deploying EV charging stations that are fueled by a hybrid system that combines solar and wind energy. *In order to effectively utilize renewable energy, solar panels and wind turbines are integrated into the architecture. Given the geographical and climatic variety of India, the hybrid system reduces the intermittent nature of individual renewable energy sources by ensuring constant power output. The best configurations are found through thorough feasibility studies and simulations that aim to optimize energy output while reducing expenses. The analysis of crucial elements including system scale, grid integration tactics, and location choice is extensive to guarantee economic feasibility, scalability, and dependability. In addition, the study looks at how renewable energy development and EV charging infrastructure may work together to further India's larger sustainability objectives. Apart from technological aspects, the research delves into regulatory structures, policy inducements, and commercial strategies that facilitate the implementation and functioning of these charging stations. Facilitating implementation and promoting acceptance necessitates collaboration with pertinent players, such as government agencies, electricity providers, and electric vehicle manufacturers. The suggested hybrid EV charging stations have several advantages, such as lower carbon emissions, increased energy independence, and improved resistance to power outages. Additionally, they support economic growth, technological advancement, and job creation in the rapidly expanding renewable energy industry.*

To sum up, this study offers a thorough methodology that is especially adapted to the Indian context for developing and implementing EV charging infrastructure that is powered by renewable energy sources. This program is a big step toward a sustainable and inclusive transportation ecology as it makes use of the nation's enormous solar and wind resources.

Key Words: **Electric Vehicle (EV) Charging Stations1 , Wind-Solar Hybrid System2 , Renewable Energy Integration3, Hybrid energy Management4, Solar Energy5, wind energy6, Sustainable Transportation7.**

1.INTRODUCTION

A paradigm shift toward the utilization of renewable energy resources has been brought about by the growing need for clean and sustainable energy solutions as well as the necessity to reduce climate change. The investigation of novel and effective energy systems becomes essential in the setting of India, a nation with rapidly increasing energy demands and a dedication to lowering its carbon imprint. In order to address the challenges of combining solar and wind technologies in the varied environment of India, this research study explores the complicated field of the Design and Performance Evaluation of a Wind-Solar Hybrid System in India. Given its large geographic area and diverse climate, India presents a special mix of potential as well as obstacles for the use of renewable energy. The nation boasts an abundance of solar and wind energy resources, which when combined can produce a steady and sustainable power source. Combining solar and wind power technology might help reduce the intermittent nature of each power source and produce more constant and dependable electricity. The main goal of this research is to create a hybrid system that best integrates solar and wind power while taking into account India's unique geographic features and climatic circumstances. The construction of an effective hybrid system and the comprehensive performance evaluation that follows are the two main contributions of this work. The goal of the study is to provide important new insights into the complex interplay of design concerns, technical developments, and such hybrid systems' feasibility from an economic and environmental standpoint. India has demonstrated a strong commitment to expanding its renewable energy infrastructure as the world transitions to a low-carbon future. This study aims to close the knowledge gap between theory and application by offering a thorough grasp of the opportunities and problems related to wind-solar hybrid systems in the Indian setting. In doing so, it hopes to educate academics, energy planners, and politicians on these systems' potential to support India's sustainable energy goals and promote a cleaner, greener energy environment across the country.

The growing challenges posed by resource depletion, climate change, and environmental degradation have called attention to the need for a significant shift in our approach to energy production. Renewable energy sources, such as solar and wind, significantly improve energy security, lessen dependency on non-renewable resources, and reduce greenhouse gas emissions. These sources offer a sustainable and environmentally acceptable alternative, supporting global efforts to create a low-carbon future.

- An electrical power source is now one of the most important things.
- Two sources are used to generate power.
- India generated 77% of its power in 2020 from fossil fuels, of which 72.5% came from coal, 4.2% from natural gas, and 0.3% from oil.
- The nation said in June that it will aim to produce half of its power from renewable sources by 2030.

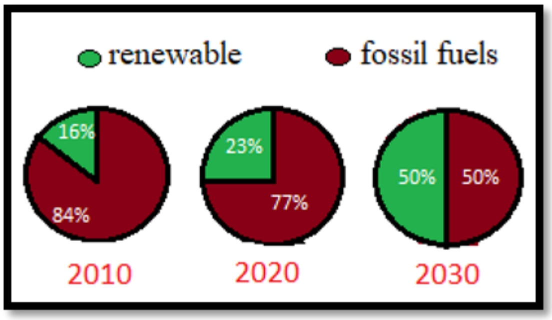

Fig1 data of past and target of uses renewable and fossil fuels.

The unique characteristics of wind and solar energy contribute to their appeal as renewable energy sources. The highest wind power resources are often found in areas with consistent winds, such as mountainous terrain or coastal locations. On the other hand, because solar energy primarily depends on exposure to sunlight, it functions best in regions with lots of sunshine. The complementary characteristics of these two sources have led to the development of hybrid systems that aim to maximize energy output and grid resilience. In every location, both energy sources are more readily available. It requires less money. No specific site is required for the installation of this system.

Two renewable energy sources—wind and solar—are combined in a wind-solar hybrid system to produce electricity. This system is designed to generate power using solar panels and small wind turbine generators.

Comprehending the functioning of solar and wind energy systems is crucial for an understanding of solar wind hybrid systems. A solar power system is a device that uses solar panels to produce electricity from solar radiation. The block diagram of the solar wind hybrid system, which produces electricity using solar panels and wind turbines, is shown in the graphic.

Wind energy, generated by wind turbines and generators, is another renewable energy source that may be used to generate electricity.

A fan with two or three blades that spins in reaction to wind is known as a wind turbine; the rotation's axis must coincide with the direction of the wind. Because a gear box is used to move energy mechanically from one device to another, it is known as a high-precision mechanical system. Wind turbines come in many different varieties, but the two most popular types are vertical and horizontal axis turbines.

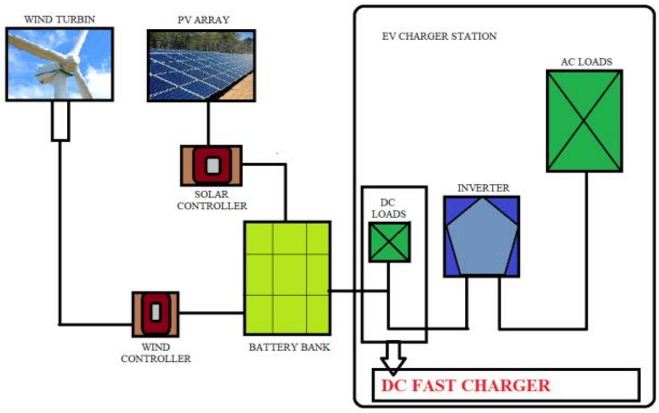

Fig2 block diagram of hybrid (wind-solar) charging system.

The three primary parts of a solar power system are solar panels, solar photovoltaic cells, and energy-storage batteries. DC power, or electrical energy generated by the sun, can be used to power DC loads directly, store it in batteries, or feed AC loads via an inverter. Solar energy is only available throughout the day, however wind energy may be used all day long depending on meteorological conditions.

The combination of wind and solar energy allows the system to provide electricity almost year-round. The main components of the wind solar hybrid system are the inverter, charge controller, batteries, solar photovoltaic panels, wind aero generator, and tower. With the use of an inverter, the wind-solar hybrid system's electricity may be used to operate air conditioning units and recharge batteries. A tower that is at least eighteen meters above the ground is necessary for the installation of a wind aero-generator. Because of its height, the aero-generator can capture wind more quickly, producing more power.

India's fast industrialization and urbanization have raised the country's transportation needs, which has resulted in energy instability and environmental deterioration. It is imperative to move toward sustainable transportation options that lower greenhouse gas emissions and dependency on fossil fuels in order to address these issues. As a viable substitute, electric cars (EVs) have gained popularity because of their reduced emissions and significant energy savings. But the absence of sufficient infrastructure for charging EVs prevents them from being widely adopted, especially in a nation as big and varied as India. This research suggests a unique solution to close this gap: the development and use of EV charging stations that are fueled by a hybrid wind-solar system. Using the wind and solar energy that are abundant in India, this hybrid system provides a scalable and sustainable way to power EV charging infrastructure all throughout the nation. The hybrid system can reduce the erratic nature of separate renewable energy sources by combining solar and wind turbines, guaranteeing a steady and dependable supply of electricity to charging stations. Such hybrid EV charging station design and deployment call for a multidisciplinary strategy that includes engineering, economics, politics, and stakeholder involvement. Our goal in writing this article is to present a thorough framework for the planning, implementation, and management of renewable energy-powered EV charging infrastructure in India.

In addition to addressing the infrastructural issues related to EV adoption, the installation of wind-solar hybrid EV charging stations advances India's larger sustainability objectives. This program supports India's objectives to fight climate change and advance the development of renewable energy sources by lowering carbon emissions, improving energy independence, and encouraging technical innovation.

The technical components of developing hybrid electric vehicle (EV) charging stations, such as system sizing, location selection, and grid integration techniques, will be covered in detail in this study. We will also discuss the policy and regulatory frameworks required to facilitate the installation of this kind of infrastructure, as well as the advantages it will have for the economy and the environment.

In general, the development and implementation of wind-solar hybrid electric vehicle charging stations constitute a noteworthy advancement in the establishment of a robust and sustainable transportation network in India. We can take advantage of this revolutionary initiative's possibilities and solve its problems by working together with government agencies, corporate sector stakeholders, and civil society.

2. MATERIAL AND METHODOLOGY

2.1 Mapping of Geographic Information Systems:

The primary goal is to evaluate and map India's various areas' potential for solar and wind energy. The mapping of Geographic Information Systems (GIS) is an essential tool for determining the best places in India to put solar panels and wind turbines. Acquire GIS information about land usage, terrain, and weather conditions. Include temperature, sun radiation, and wind speed data in the GIS system. Determine the best places for solar panels and wind turbines based on the availability of resources. Examine both temporal and geographical differences to identify the best deployment tactics.

2.2 Wind Turbine and Solar Panel Selection

In the wind turbine Examine all of the various wind turbine types in detail, taking into account variables like hub height, cut-in wind speed, and rated power. Examine wind turbine designs with horizontal and vertical axes. Examine the power output parameters and efficiency curves of the wind turbine models that made the short list. Think about how the turbine performs in different wind speed scenarios. Analyze each wind turbine model's maintenance needs and longevity. Examine the selected turbines' anticipated lifespan and dependability.

While choosing solar panels Examine several photovoltaic (PV) technologies, such as thin-film, polycrystalline, and monocrystalline. Evaluate each technology's cost, space needs, and efficiency. To comprehend how solar panels function in various temperature environments, take into account temperature coefficients. Examine the effect of high temperatures on solar panel efficiency. Examine how flexible solar panel installation is, taking into account things like tracking systems, ground-mounted systems, and rooftop installation.

2.3 Materials are use in hybrid system

- Rotor blades: For strength and flexibility, fiberglass or carbon fiber reinforced composites are frequently used. Tower: For stability and durability, steel or concrete are typically used in construction. The generator housing is composed of aluminum or cast iron for heat dissipation and durability.
- PV modules (solar panels): Constructed from thin-film materials or crystalline silicon. There are two primary varieties of crystalline silicon panels that are widely used: monocrystalline and polycrystalline.
- Frame: Solar panels are structurally supported by steel or aluminum frames.
- Inverters: For effective heat dissipation, aluminum or other lightweight metals are frequently used for the housing, Devices that transform DC electricity from solar panels and wind turbines into AC power. Constructed of aluminum or other conductive materials.
- Support Structures: Frames made of steel or aluminum that hold up solar panels and wind turbines. The decision is based on many considerations, including corrosion resistance, strength, and cost.

- Mounting Systems: Aluminum or galvanized steel racks and frames for safely securing solar panels and supporting other parts.
- Battery Enclosures: Constructed from steel or reinforced plastic, these enclosures guarantee battery safety by shielding the batteries from the elements.
- Lithium-ion (Li-ion) batteries are widely utilized because of their extended cycle life, high energy density, and dependability.
- Control Systems: Electronic component protection provided by sturdy housings. PCBs, or printed circuit boards, are frequently composed of fiberglass or epoxy.
- Power cables are usually composed of copper due to its durability and conductivity.
- Control cables: made of aluminum or copper, depending on the need.
- Monitoring devices and sensors: Weather-resistant housings for the sensors, and different materials for the sensors depending on how they work.
- Communication equipment is built to resist weather conditions and is composed of materials like metal or plastic.
- Wind turbine foundations consist of steel or reinforced concrete structures that firmly anchor the wind turbine tower.
- Concrete or steel constructions that serve as a sturdy support for the installation of solar panels are called solar panel foundations.
- Enclosures: Usually constructed of polycarbonate, stainless steel, or aluminum to shield electrical components from the elements.

The wind's kinetic energy is transformed into mechanical energy by the wind turbine, and the generator subsequently turns that mechanical energy into electricity. Through the process of photovoltaics, solar panels transform sunlight into direct current (DC) power. For local or grid integration, inverters transform DC electricity from solar and wind systems into alternating current (AC). Systems for storing extra energy are used when the production of renewable energy is low. Control systems maximize the performance of solar and wind energy components according to energy consumption and environmental factors. For the purpose of assessing performance, monitoring systems continually gather information on energy production, system efficiency, and environmental factors.

Depending on the technology, design, and manufacturer of the parts used in the wind-solar hybrid system, different materials and operational details may be employed. It is important to take into account many aspects including expenses, effectiveness, and ecological consequences while choosing materials for distinct parts.

3. DESIGNING AND RESULTS

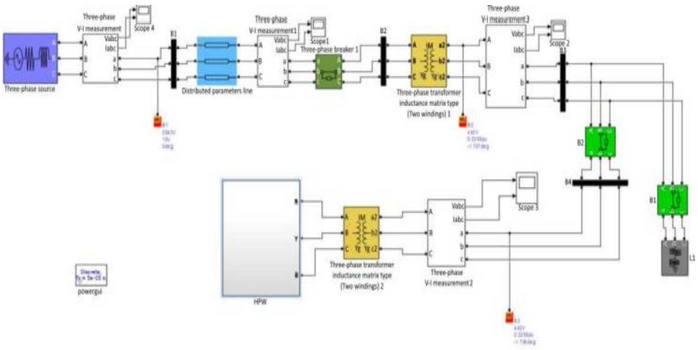

Fig 3 MATLAB diagram for a wind-solar hybrid system.

The MATLAB schematic model of the wind-solar hybrid system is displayed in Fig. 3. In order to supply the grid with the unused electricity, a grid is added to the suggested model. The grid-connected hybrid system, connected to the grid via a transformer, is depicted in the accompanying figure.

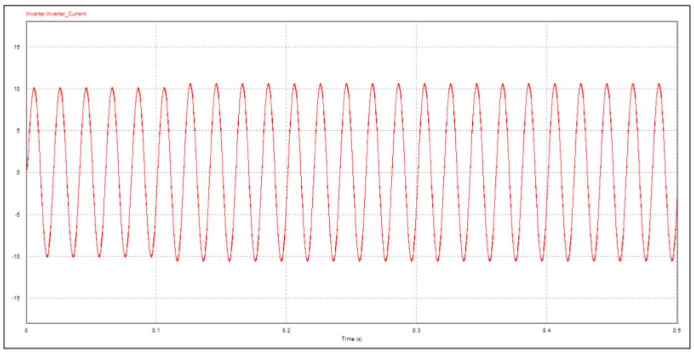

Fig 4 Output current of Inverter.

Figure 4 shows the inverter's output current. The inverter's output current is around 10 amps. The suggested approach uses an inverter to change the two-energy system's DC output power into AC. The inverter receives an addition of DC electricity from the solar and wind systems. Additionally, a limiter is attached to the inverter's input to restrict the input voltage's amplitude. The limiter has an upper limit of 110 volts and a lower limit of 1005 volts. The inverter uses the sinusoidal pulse width modulation approach because it provides superior harmonic reduction. We have employed the pulse width modulation approach in the inverter circuit. An IGBT bridge was employed as the switching mechanism.

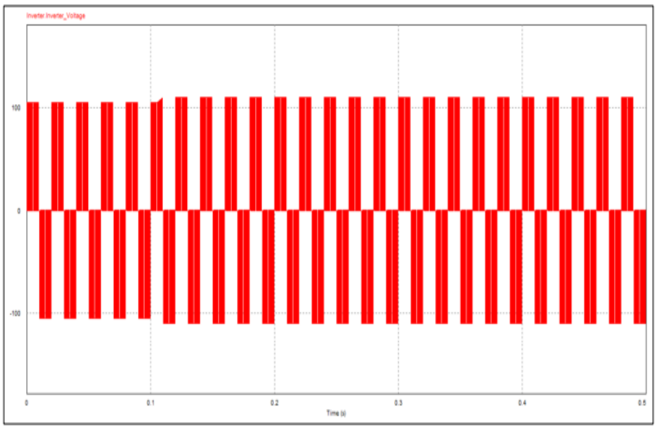

Fig. 5: Output Voltage of Inverter.

Fig. 5 shows the inverter's output voltage. The inverter produces an output voltage of 110 volts.

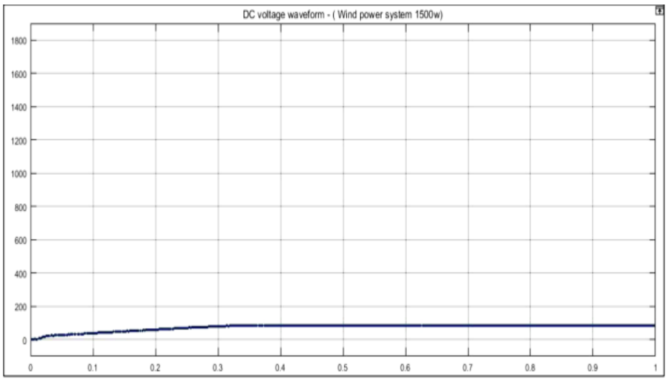

Fig 6: Output Voltage of the Rectifier.

Fig. 6 shows the rectifier's output voltage. An IGBT bridge with three phases and a PWM pulse generator is coupled via the rectifier circuit. Additionally attached to the rectifier is an L-C filter. The rectifier has a maximum voltage of about 80V. The voltage at the output is rectifying.

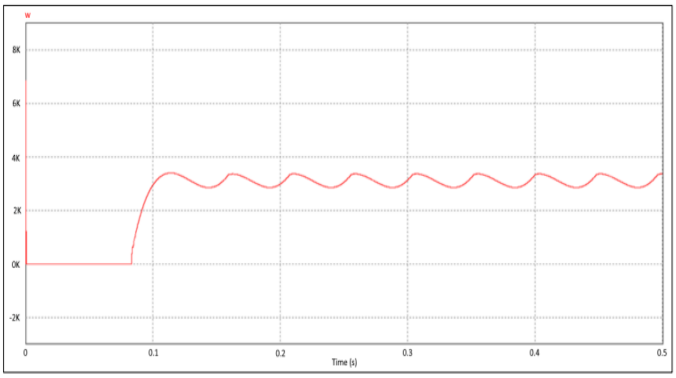

Fig 7 Power Output of Wind Turbine

The wind turbine system's output power is displayed in Fig. 7. The wind turbine's output fluctuates in tandem with variations in wind speed. When the wind speed is 12 m/s, the wind turbine's output power ranges from 4 kW to 3 kW. The maximum pitch angle for a wind turbine is 27 degrees, and the maximum pitch angle change rate is 10 degrees per second. The sample time has a value of 0.1 seconds.

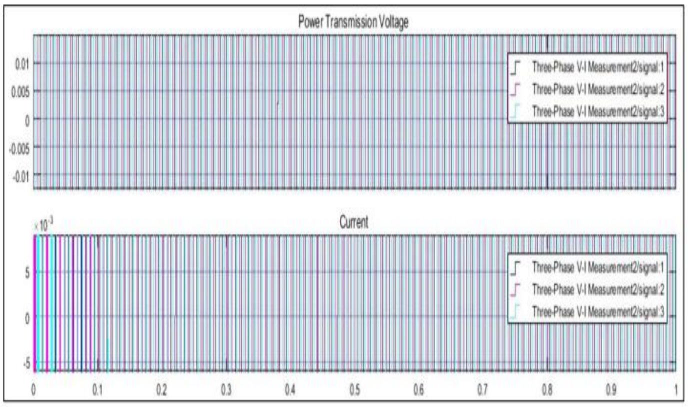

Fig 8 Output Voltage of the Hybrid System.

Fig. 8 shows the hybrid system's output voltage.

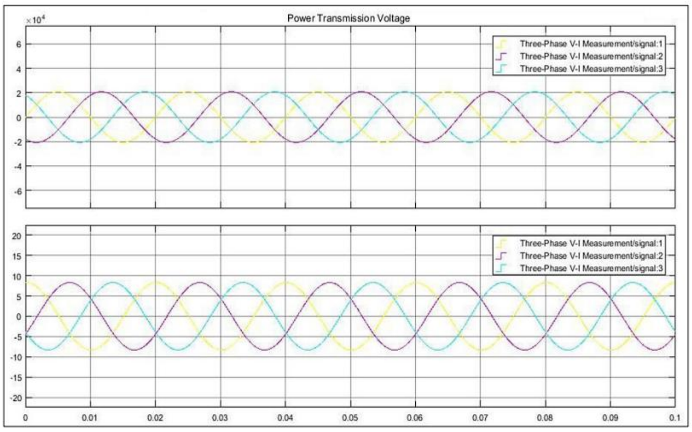

Fig 9 Output of the Grid-connected Three-Phase Generator.

The output, or power transmission voltage, of the three-phase generator linked to the grid is displayed in Figure 9.

3. CONCLUSIONS

Research Paper Conclusions: Design and Application of EV Charging Stations Running on Wind-Solar Hybrid Systems in India

The study shows that combining wind and solar electricity for EV charging stations in India is both possible and economically viable. By utilizing renewable energy sources, such stations can help to dramatically reduce carbon emissions and reliance on fossil fuels in the transportation industry.

Optimal Siting and Design: The location and design of EV charging stations are critical for increasing the efficiency of the wind-solar hybrid system. Local weather patterns, sun insolation levels, and wind speeds should all be taken into account to guarantee that the stations work optimally. technology Integration: To successfully integrate wind and solar electricity with EV charging infrastructure, innovative technology solutions are required. This comprises smart grid technologies, energy management systems, and grid-connected inverters that regulate power flow and assure steady charging operations.

Grid connection and stability are important issues when deploying EV charging stations fueled by renewable energy sources. The study underlines the need of grid integration solutions, such as energy storage devices and demand response mechanisms, in addressing possible concerns with intermittency and unpredictability in renewable energy output.

Policy and Regulatory Framework: Developing supporting policy and regulatory frameworks is critical for increasing the general use of EV charging stations powered by wind-solar hybrid systems. This includes incentives for renewable energy deployment, faster licensing processes, and grid access laws that make it easier to integrate with existing infrastructure. Environmental and social benefits: The installation of wind-solar hybrid EV charging stations has major environmental and socioeconomic implications. By lowering greenhouse gas emissions and air pollution, these stations help to enhance air quality and public health. They also create new jobs in the renewable energy sector and help India shift to a low-carbon economy.Future Directions: Future research should prioritize improving the performance and scalability of wind-solar hybrid EV charging systems. This involves investigating innovative energy storage technologies, improving forecasting capacities for renewable energy output, and determining the long-term effects on system stability and resilience. Overall, the study's findings highlight the potential for wind-solar hybrid systems to foster sustainable growth in the transportation sector and speed India's transition to a cleaner, more resilient energy future.

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