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A Hybrid Electricity Generation In Highways Using Wind And Solar Energy.

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Abstract—Renewable energy has seen an interest in sustainable energy source overcome increasing energy demands. In world-wide demand of electricity is constantly rising. As we have more number of technological advancements, multiple innovations and modernization in day-to-day life. For meeting the required demand in a world-wide, now we are heading with renewable energy resource. In renewable energy source we are implementing with hybrid technology in turn it provides more efficacy. Considering all these we are applying hybrid technology in our project by using solar and wind as main source.

A hybrid generation system in highways using solar and wind energy involves integrating solar panels and wind turbines. Infrastructure of highways for renewable energy from sun and wind is considered solar power generation peaking during day, especially in sunny conditions, while wind energy can be more consistent and often increases at night or during wind days when solar generation is lower. Supply chain for remote areas is currently not possible through extension of grid, since the connection is neither cost friendly, nor eco-friendly.

Integration of hybrid electricity generation using wind and solar panels along the highways is a sustainable for of energy production .the combine power of wind and solar energy has the potential that meets the requirements of electricity generation demands. According to SDG's, it reduces the fossil fuel dependency, Eco-friendly, minimal land usage.

Keywords—Renewable Energy, Hybrid Technology, solar power, wind energy

I. INTRODUCTION

Imagine a future where highways transform into self-sustaining connection of energy. This project aims to integrate wind turbine and solar panels alongside highways. Wind turbine strategically placed near roads it harness kinetic energy of passing vehicle, while solar panels capture sun's abundant rays.

Generated electricity can illuminate highway itself, eliminating needs for traditional grid-based power. Additionally, it can power electric vehicle charging stations, encouraging adoption of sustainable transportation. The surroundings neighborhood can take advantages of energy source, reducing their reliance on fossil fuels and promoting environmental responsibility.

This project is a beginning of innovations, pushing boundaries of renewable energy technology. Researchers developing specialized wind turbine designs that adapt to vertical wind patterns around highways, while exploring methods for seamlessly an integrating solar panel into highways infrastructure. Efficient energy storage and

Management systems are also crucial, ensuring consistent power availability.

Challenges like wind turbine safes, solar panel efficiency in highways environments, and integrating. By overcoming these obstacles, hybrid renewable sources in highways systems have potential to revolutionize way we power our

transportation infrastructure and communities, creating a more sustainable future.

With the rise of global temperatures and the diminishing reserves of fossil fuels increasing day by day, most industries are looking as sustainable energy, eco-friendly, energy solutions to protect earth for future generation. According to the research, hydropower, wind and solar energy holds power demands. But alone, wind energy holding capable of producing large amount of power but its unpredictable as keeps on changing. Solar energy is available during the day, while wind energy is available during the night are on cloudy days. If one energy source can be used to balance the load requirements.

A review of solar and wind energy system integrating solar, wind, and biomass sources showcases their diverse principles, types, and applications across various sectors. Research in this field explores synergistic combination of multiple solar and wind energy sources to overcome individual limitations and maximize energy output. These systems often employ control strategies to optimize energy generation, storage, and distribution, ensuring reliability and stability in power supply. Literature highlights for hybrid systems, including off grid electrification in remote areas, grid connected power generation, and decentralized energy production for industrial and residential use. Furthermore, there is a growing trend of incorporating hybrid renewable energy systems into micro grids and intelligent energy networks, enabling more efficient and sustainable energy management. Studies emphasize importance of considering site specific conditions, resource availability, and techno economic factors when designing and implementing hybrid renewable energy systems, paving way for a more resilient and environmentally friendly energy future.

Recent developments in energy gathering crops from road infrastructure have seen significant innovations aimed at capturing untapped kinetic, thermal, and solar energy present in road environments. Technological advancements have resulted in the development of piezoelectric materials capable of producing electricity through the mechanical stress caused by vehicles passing over them, thermoelectric generators that transform heat from asphalt into electrical power, and photovoltaic road panels that capture solar energy. Research has been focused on improving durability, efficiency, and cost effectiveness of these systems to withstand harsh conditions of road environments and heavy load of traffic. Experimental installations in various countries have demonstrated potential of se technologies to contribute to power grid and power roadside infrastructure, such as lighting

and sensors for intelligent transportation systems. Challenges remain in terms of scaling up these technologies and ensuring their long-term economic viability. However, ongoing research and pilot projects continue to optimize performance and integration of energy harvesting systems into road infrastructure, highlighting their potential to significantly contribute to sustainable energy goals.

II. OVER VIEW

This project envisions a future where highways are not just pathways for vehicles but also innovative hubs for sustainable energy generation. It proposes the integration of wind turbines and solar panels along highways to create a self-sustaining energy generation system. Idea capitalizes on the energy produced by passing vehicles, which can be harnessed by strategically placed wind turbines, and the abundant sunlight, captured by solar panels installed alongside or on medians of highways.

This hybrid system's generated electricity can fulfil various needs, such as lighting up highways, energizing electric vehicle (EV) charging stations along these roads, and supplying excess power to adjacent communities. This not only promises to reduce dependency on traditional grid-based power and fossil fuels but also supports adoption of sustainable transportation solutions.

Literature survey encompasses various studies and research efforts related to wind and solar energy systems, focusing on their principles, applications, and the advanced technologies like vertical axis wind turbines (VAWTs), energy harvesting from road infrastructure, and perovskite solar cells. These studies highlight the technological advancements, challenges, and possible approaches to enhance energy harvesting, efficiency, and overall sustainability of such systems.

Objectives of project are detailed, aiming at understanding and enhancing performance and viability of integrating renewable energy system on highways. These include powering highway lights, establishing EV charging infrastructure, enhancing traffic management systems, and providing power for other highway utilities, all through renewable energy sources. Project also aims to tackle the technical challenges of maximizing power capture from both renewable components under varying environmental conditions.

III. OBJECTIVE

Main objective of a hybrid wind and solar power generation system on highways have ability to harness the combined potential of wind and solar energy its offer a variety of application along the highway, including :

- Renewable energy generation.
- Promoting SDG's [Social development goals].
- Green technology implementation.
- Obtaining maximum benefits with minimal coating.
- Technology which supports Grid integration system.
- Utilization of the available infrastructure.

IV. BLOCK DAIGRAM

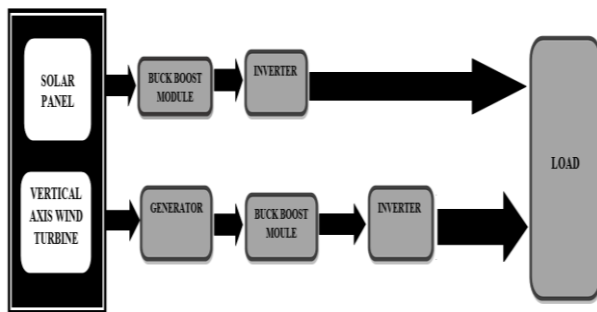


Fig. 1: Block Diagram of Entire System

This system integrates both energy sources for electricity generation. As wind turbine starts rotating, turbine shaft and generator shaft is coupled together. As generator rotates an EMF is induced in the system. This generated voltage is given to buck boost module to filter the generated voltage and give constant 12V DC-output. This constant voltage is again given to an inverter circuit to convert it from DC to AC. Similarly, a solar panel transforms sunlight into solar energy and solar energy converts into electrical energy at a nominal voltage of 12V. A vertical axis wind turbine is employed to harness wind energy, driving a generator with 1:4 rotation ratio between turbine and generator shafts. This rotation induces an electromotive force (EMF) in generator, generating current. Voltage and current from generator are regulated by a buck boost module to provide a stable 12V DC output. This output is fed into an inverter circuit to convert it into approximately single phase 230V AC, suitable for powering AC loads.

V. METHODOLOGY

To develop a hybrid electrical generation system for highways utilizing wind and solar energy, a systematic methodology is essential. Initially, a through site assessment should be conducted to determine feasibility of implementing system. This assessment should involve factor such as minimum wind speed, solar irradiance levels, available land area, and environmental considerations. Following this appropriate equipment, including vertical axis wind turbines and solar panels, should be selected based on site specific condition and energy requirements.

Once, equipment is procured, installation should it is important to conduct task with through deliberation of factors such as optimal positioning and orientation to maximize energy capture. Additionally, a robust support structure must be erected to ensure stability and durability of system, especially considering potential exposure to high winds and wear conditions.

Next, electrical component, including generators buck boost modules, and inverters, should be integrated into system to efficiently convert capture wind energy and solar energy into usable electricity. This integration should be done accordance with safety standards and regulations to ensure reliability and performances system.

Furthermore, a monitoring and control system should be implemented to continuously monitor energy production, system performance and environmental conditions. This will give permission for timely detection of any issues or anomalies and facilitate remote management and optimization of system operations.

Finally, regular maintenance and upkeep of hybrid electrical generation system are crucial to ensure its long term reliability and performance. This includes periodical inspections, cleaning of solar panels and wind turbines, lubrication of moving parts and replacement of any worn out components.

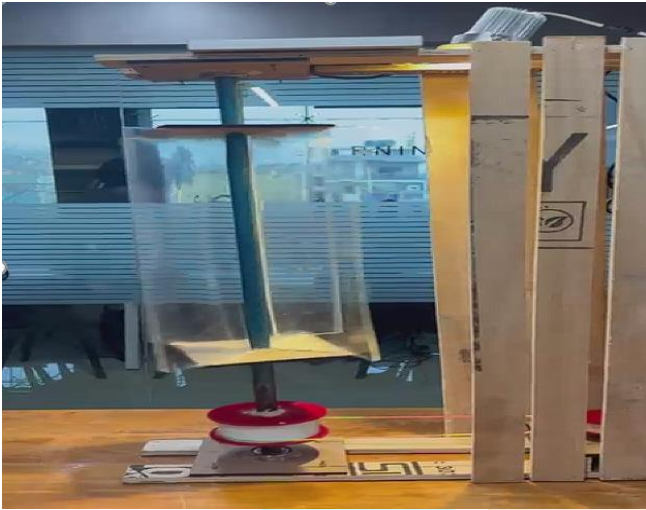


Fig.2: Outcome of Hybrid Generation in Highways

Study indicates that integration of VAWTs and solar panels along highways can yield substantial energy production. Combination of wind and solar resources ensure continuous energy generation, with potential to meet a significant portion of electricity demand for highways infrastructure. Environmental benefits, including reduce carbon emissions and dependence on fossil fuels, highlights sustainability advantages of this approach. This project generates single phase 230V of voltage with 80% of efficacy.

Concept of hybrid electricity generation on highways using both wind and solar energy represents a forward thinking approach to sustainable infrastructure development strategic placement of such hybrid system on highways can capitalize on unique environmental and structural aspects of locations to enhance energy production efficiency. In essence, this power generation system integrates to energy sources, specifically a wind turbine, to create hybrid system. To wind energy and solar panel to add on further electrical energy, essentially providing energy throughout day. Power banks can store this energy, making it available for a variety of applications supply to remotely location areas, this article discusses generation of energy from solar and wind sources that are combined to produce electricity at a reasonable cost while ensuring environmental sustainability.

This development of a hybrid electrical generation system utilizing wind and solar energy along highways presents a promising solution for sustainable electricity generation. Through a systematic methodology involving site assessment, equipment selection, installation, integration of electrical components, monitoring, and maintenance, such a system can effectively harness renewable energy resources to provide continuous and reliable power supply. Its including reduced reliance on fossil fuels, enhanced energy independence, cost savings, infrastructure enhancement, and environmental preservation. By promoting adoption of clean energy technologies and mitigating impacts of climate change, implementation of hybrid electrical generation systems along highways contributes to a more sustainable and robust energy future.

VIII. FUTURE SCOPE

The utilization of renewable energy in hybrid electrical generation systems along highways holds great promise and offers vast opportunities. The integration of smart grid technologies can enhance the distribution and consumption of energy, enabling improved coordination between energy generation, storage, and demand. These avenues present potential for further development and expansion.

1. **Advanced Technology Integration:** Continued advancements in wind turbine and solar panel technology, such as improved efficiency, durability, and affordability, will enhance performance and viability of hybrid systems. Integration with energy storage solutions like batteries could enable better management of fluctuating renewable energy output, ensuring consistent power supply along highways.

2. **Smart Grid Integration:** The incorporation of smart grid technologies holds the capacity to improve the distribution of energy and consumption, facilitating improved coordination among energy generation, storage, and demand. This could include demand response mechanisms, grid balancing services, and real time monitoring and control systems to maximize system efficiency and reliability.

3. **Micro grid Deployment:** concept of micro grids, decentralized energy systems capable of operating independently or in conjunction with main grid, holds significant potential for highways. Implementing micro grids along highways could enhance energy resilience, especially in remote areas, and promote the implement of electrical vehicle charging infrastructure.

4. **Integration with Transportation Infrastructure:** The combination of solar and wind energy generation systems with transportation infrastructure, such as electric vehicle charging stations and roadway lighting, has the potential to foster sustainable transportation solutions and generate synergistic effects. Moreover, the combination of solar and wind energy generation into noise barriers and highway structures can effectively utilize land resources and amplify environmental advantages.

5. **Research and Development:** It is crucial in advancing innovation and overcoming technical obstacles related to hybrid energy systems. This includes optimizing energy conversion efficiency, lowering equipment expenses, and improving system dependability and expandability.

6. **Policy Support and Incentives:** Government policies and incentives are essential in stimulating the widespread adoption of hybrid electrical generation systems along highways as they encourage of solar and wind energy and the implement of necessary infrastructure. Supportive regulatory frameworks, financial incentives, and public private partnerships can accelerate project implementation and facilitate market growth.

7. **Community Engagement and Education:** It is crucial to conduct community engagement and public awareness campaigns in secure backing for renewable energy initiatives and ensure successful implementation. Educating stakeholders about benefits of energy, addressing concerns, and fostering local participation can help build trust and facilitate project acceptance.

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