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# DEVELOPMENT OF DYNAMO-SOLAR POWERED E-BICYCLE

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**Abstract:** In the current situation, a hybrid bicycle powered by solar and dynamo will assist in resolving the main issue of fuel prices, particularly the continually rising cost of petrol. Once more, vehicle-related pollution in urban areas and metropolises is steadily rising. An attempt is being made to look into some other alternate energy sources to power the bicycle in order to get around these issues. Once more, buying cars (motorcycles, scooters, or mopeds) for every social class is likewise out of reach. In light of this, efforts were underway to find a remedy for the environmental pollution and a means of helping these economically disadvantaged individuals. The direct current motor installed in the front axle housing powers the solar and dynamo-assisted hybrid bicycle utilising electrical power. The battery will be charged by the solar panels on the carriage, which will then power the hub motor. A pair of 48-volt dynamos mounted on the back wheel of the bicycle will charge the battery when it is travelling on the road, and the solar panel will charge the battery while the bike is parked or idle. For a two-wheeler or a bicycle with a gear shifting system, this setup will take the place of the gasoline engine, gearbox and fuel tank.

**Keyword:** Fuel prices, solar, charge, bicycle, pollution.

## I. INTRODUCTION

The Solar-Dynamo Powered E-Cycle is a groundbreaking innovation that combines renewable energy sources, advanced propulsion technology, and smart features to offer an eco-friendly and efficient mode of transportation. This innovative e-cycle is a paradigm shift in urban and rural mobility, addressing climate change and environmental degradation concerns. The Solar-Dynamo Powered E-Cycle integrates solar panels and a dynamo generator, harnessing sunlight to charge the lithium-ion battery. The dynamo generator generates electricity through electromagnetic induction, which is channelled into the battery, ensuring uninterrupted operation and extending the e-cycle's range. The BLDC hub motor, integrated directly into the rear wheel hub, delivers smooth and responsive acceleration, reducing maintenance requirements and ensuring uninterrupted operation. The Solar-Dynamo Powered E-Cycle is a sustainable and efficient e-cycle that optimizes energy utilization and extends its range. Its synergy with a solar-dynamo charging system and BLDC hub motor enhances its performance and energy efficiency. This innovative e-cycle is particularly useful in rural areas like India, where agricultural activities and heavy-weight transportation are prevalent. Its solar charging capability allows farmers to traverse expansive farmlands, facilitating efficient crop monitoring, irrigation management, and pest control. The BLDC hub motor further enhances its utility in agricultural settings, allowing farmers to transport agricultural inputs, equipment, and harvested produce with minimal effort and energy expenditure. The e-cycle's affordability and scalability make it accessible to a wide range of users, fostering economic growth and sustainable development in rural areas. As countries prioritize sustainability and rural development, the Solar-Dynamo Powered E-Cycle is poised to play a pivotal role in shaping the future of mobility and agriculture in both urban and rural areas.

## II. OBJECTIVES

The objectives of the project:

- To develop an environmentally friendly vehicle as well as zero emission from the vehicle.
- To store regenerated power from dynamo in to battery.
- To control the speed of the bicycle using speed controller.

## III. METHODOLOGY

### A. BLOCK DIAGRAM

The Solar and Dynamo Bicycle uses a dual power generation system, extracting energy from a wheel-driven dynamo motor and a solar panel. The electric power is stored in a battery and converted into alternating current, propelling the

 

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sprocket wheel. This innovative transportation solution offers a sustainable, eco-friendly mode of travel, reducing reliance on conventional power sources and showcasing a forward-thinking approach to clean and renewable energy integration in urban mobility.

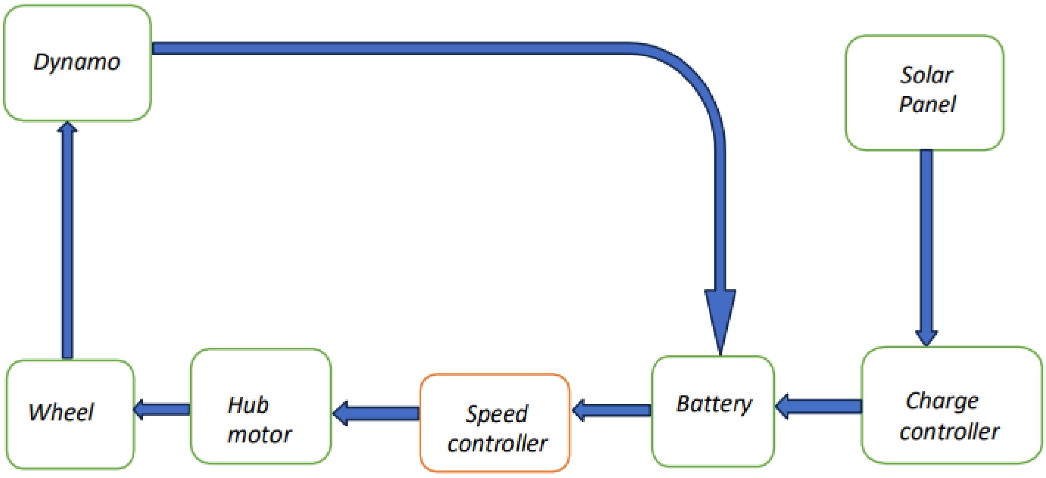


Figure 1 Block Diagram of Dynamo-Solar Powered E-Bicycle.

## IV. HARDWARE DESCRIPTION

*4.1 Brushless DCHubMotor*

A Brushless Direct Current (BLDC) Hub motor uses electromagnetic fields to manipulate its stationary windings, allowing the outer part to turn the wheel. This design eliminates physical contact between components and uses DC electricity to drive each phase. A closed-loop controller regulates speed and torque. The coils in BLDC motors are reversed, with the inner part rotating around the magnet. Hall-effect sensors detect the rotor's position, guiding the controller to activate the coils for precise rotation. This design enhances efficiency and performance.

Figure 2 Brushless DC Motor

*4.2 Solar Pannel*

Solar panels, also known as photovoltaic panels, convert sunlight into electricity through individual solar cells. The inverter converts the DC electricity into AC, which is used in homes and businesses. Solar panels are a sustainable, renewable energy solution, producing clean electricity without harmful emissions. They are environmentally friendly, reducing dependence on finite resources. They also offer economic benefits, as they can generate electricity for decades with minimal maintenance costs, leading to significant savings on electricity bills. Government incentives also encourage solar energy adoption.

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Figure 3 Solar Pannel

4.2.1 Solar Cell

The photovoltaic effect, which explains how some materials produce an electric current when exposed to light, is the basis for how solar cells, often referred to as photovoltaic cells, work. A semiconductor, usually silicon, that has been doped with impurities to form a p-n junction is at the core of a solar cell.

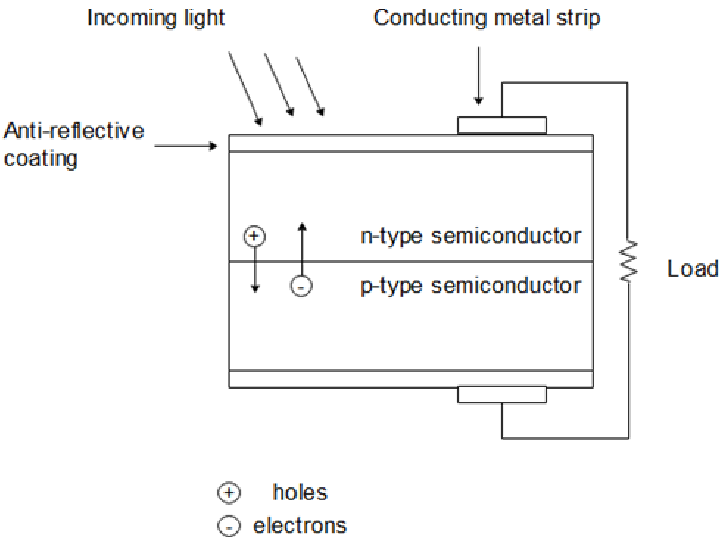


Figure 4 Solar Cell

Energy is transferred to the semiconductor material when photons from sunshine strike the solar cell's surface. Electrons in the material are excited by this energy, separating from their atoms to form electron-hole pairs. These free electrons are driven towards the n-type area and the positively charged holes towards the p-type region by the intrinsic electric field at the p-n junction.

When an external circuit is connected, the voltage differential caused by this charge separation between the two areas produces an electric current. Engineers can maximise the photovoltaic conversion process' efficiency by regulating the solar cell's structure and material characteristics, such as its thickness and doping concentration.
In conclusion, the basic idea behind a solar cell is the photovoltaic effect in semiconductor materials, which transforms light energy into electrical energy and produces a clean, sustainable energy source.

*4.3 Charge Controller*

A solar charge controller is a vital component in a solar power system, responsible for regulating the voltage and current from solar panels to ensure efficient and safe charging of batteries or other energy storage devices. Its primary function is to prevent overcharging, over- discharging, and other potentially damaging conditions that can occur in battery-based solar systems.


Figure 4 Charge Controller

Solar charge controllers are divided into two types: PWM (Pulse Width Modulation) and MPPT (Maximum Power Point Tracking). PWM controllers regulate the charging process by interrupting electricity flow from solar panels to batteries, but are less efficient. MPPT controllers are more sophisticated, continuously adjusting voltage and current to ensure maximum power transfer to batteries. They also offer features like temperature compensation, load control, and data monitoring for real-time system performance and battery status.

*4.4 Dynamo*

A dynamo is an electrical generator producing direct current through a commutator, is a vital component in a bicycle's electrical power generation system. The choice of dynamo is contingent on the capacities of the battery and hub motor; in this case, with a 48 Volt battery and a 48 Volt hub motor, two 24 Volt dynamos were selected and intricately affixed to the rear wheel of the bicycle using arc welding.

Figure 5 Dynamo

Dynamos are bicycle-powered electrical systems that convert mechanical energy into electrical form. They consist of a stator, armature, and commutator. The armature generates electric pulses, while the commutator reverses the current during each half-turn. This process ensures a unidirectional flow of electricity, contributing to a sustainable and eco-friendly mode of transportation. The dynamo's intricate interplay is crucial for efficient power generation.

*4.5 Battery*

The lead acid battery is a type of rechargeable battery first invented in 1859 by French Physicist Gaston Plante. It is the first type of rechargeable battery ever created. Compared to Modern rechargeable batteries, lead-acid batteries have relatively low energy density.


Figure 6 Battery

 

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Lead-acid batteries are low-cost, high surge current generators used in motor vehicles. Despite their short cycle lifespan and long charging times, they are widely used due to their affordability. In 1999, lead acid battery sales accounted for 40-50% of global battery sales, worth about $15 billion. Large-format lead-acid designs are used in backup power supplies, emergency power systems, and stand-alone power systems.

4.6 Speed Controller

A DC motor speed controller, device that modifies the voltage or current applied to a DC motor in order to control its speed. These controllers are frequently found in a variety of settings where precise speed control is necessary, ranging from industrial machinery to modest home appliances.

Figure 7 Speed Controller

DC motor speed control can be achieved by adjusting voltage, which is commonly used in basic applications. However, more sophisticated speed controllers use pulse width modulation (PWM) techniques to control motor speed more precisely. PWM involves rapidly switching power and varying pulse width, allowing for finer control of motor speed.

## V. RESULTS AND DISCUSSION

The development of a model for an electric bicycle shows a completely functional implementation that fits the block diagram. A unified and effective system is ensured by this model's integration of multiple hardware components.
The BLDC (Brushless DC) hub motor, which is positioned strategically on the back wheel, is the essential component of this electric bicycle. For the best stability and propulsion, this location is essential. For electric bicycles, the BLDC hub motor is preferred due to its effectiveness, dependability, and maintenance-free operation.

As the main energy source, a battery is used to power the hub motor. Because it stores energy produced by two renewable sources—solar panels and a dynamo mounted on the front wheel—the battery plays a vital role. This configuration serves as both the bicycle's power source and an example of the "regeneration" concept. By harnessing kinetic energy that would otherwise be squandered, the dynamo produces power when the bicycle is moving, especially during coasting or braking.

Figure 8 Result of Dynamo-Solar Powered E-Bicycle

By using solar energy to charge the battery, the solar panels offer an extra energy source. The bicycle's efficiency and sustainability are improved by this dual-source charging system, which lessens the need for traditional charging techniques.

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The DC speed controller, which is situated between the hub motor and the battery, is essential to the operation of the system. In order to maintain a responsive and comfortable riding experience, this controller is crucial for controlling the motor's speed. Based on throttle input, it modifies the motor's output, enabling the rider to change speed as necessary. The DC speed controller's accuracy guarantees that the motor runs within safe bounds, maximising efficiency and battery life.

The solar charge controller's job is to keep an eye on and control the power flow in this system. This gadget is essential for controlling the power delivered to the motor and preserving the health of the battery. It ensures that the battery is charged effectively and safely by supervising the charging process from the dynamo and the solar panels. In addition to controlling the hub motor's power use, the solar charge controller ensures a steady and regulated energy supply.

The model of electric bicycles presented combines cutting-edge parts with renewable energy sources to produce an effective and environmentally friendly form of transportation. This model not only satisfies design requirements but also encourages energy conservation and regeneration by utilising a solar charge controller, a DC speed controller, a BLDC hub motor, and a sturdy battery system. This creative strategy opens the door for more sustainable and environmentally friendly mobility options by highlighting the possibilities of combining renewable energy with contemporary transportation technologies.

The major outcomes of this project as follows-
• Conversion of traditional bicycle to eco-friendly E- bicycle.
• Faster transportation than conventional bicycle.
• Controlled speed after using speed controller

## VI. APPLICATIONS

Some of the applications of the project are:

1. Urban commuting : It is ideal for eco-friendly daily travel within cities, offering a sustainable alternative that helps reduce pollution and promote greener living. By encouraging the use of efficient transportation modes, it significantly reduces traffic congestion and alleviates parking challenges, making city travel smoother and more convenient. Furthermore, it aligns with and supports smart city transportation initiatives, fostering a modern, connected, and sustainable urban mobility ecosystem.
2. Last-mile delivery services: Commonly used by courier, food, and parcel companies, offer a cost-effective and sustainable solution for short-distance logistics, operating efficiently even in areas with limited charging infrastructure.
3. Rural and remote area transportation: It is well-suited for regions with limited electricity access, using solar charging to ensure mobility without reliance on power grids, benefiting students, farmers, and rural healthcare workers.
4. Tourism and recreational use is ideal for sightseeing in eco-parks and resorts, promoting green tourism through low-impact travel while offering quiet, effortless rides that enhance the visitor experience.
5. Emergency and relief operations : That can benefit greatly from this mode of transport, as it is effective in disaster-hit or remote areas where fuel or electricity is unavailable. Its reliability in low-resource settings makes it suitable for carrying medical supplies, communication equipment, and other essential resources to ensure timely aid and support.

## VII. ADVANTAGES

Some of the Advantages are:

1. Eco-Friendly Transportation: Eco-friendly transportation reduces dependence on fossil fuels, produces zero emissions during operation, and promotes clean, green urban mobility.
2. Renewable Energy Utilization: By using solar power to recharge batteries and a dynamo system to capture kinetic energy during pedaling or braking, it ensures efficient energy harvesting even on cloudy days or at night with dynamo backup.
3. Cost Efficiency: It offers minimal running costs compared to petrol vehicles, lowers electricity bills through solar charging, and reduces maintenance expenses due to fewer mechanical components.
4. Extended Battery Life: Continuous solar panel charging prevents deep discharge, while the dynamo adds extra power during motion, helping maintain battery health and prolong its lifespan.

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## VIII. LIMITATION

Some of the limitations are:

1. High Initial Cost: The inclusion of solar panels, efficient dynamos, advanced batteries, and control systems increases production costs, making the initial price less affordable for some consumers.
2. Limited Solar Efficiency: Small solar panels generate limited power, with performance dropping in cloudy or shaded areas, leading to long charging times if relying solely on solar energy.
3. Added Weight and Complexity: Solar, dynamo, and battery systems add weight and design complexity, reducing maneuverability and making repairs more challenging compared to regular bikes.
4. Maintenance Challenges: With more components, the chances of malfunction increase, and specialized parts like solar cells and dynamos require skilled repairs and regular maintenance for optimal performance.

## IX. FUTURE SCOPE

The technological and societal futures discussed in this study have advanced to a tolerable point. Future research will find ways to charge batteries naturally without using energy. Today, we must consider the cycle's future reuse notion in order to limit emissions. The victimisation microcontroller will automate the machines.

- Improved Solar Panel Efficiency will increase energy generation, even in low-light conditions.
- Advanced Battery Technology will provide longer-lasting power with shorter chargingtimes.
- Lighter Materials will reduce the weight of solar panels and dynamo systems, enhancing performance.
- Wireless Charging Integration could allow for seamless energy transfer while riding or parked.

## XII. CONCLUSION

A significant advancement in environmentally friendly transportation options has been made with the design and development of the Dynamo-Solar powered E-bicycle. This cutting-edge e-bike provides customers with a practical, economical, and environmentally responsible way to commute by combining solar power and dynamic regeneration technology. This project highlights how renewable energy has the ability to completely transform personal mobility through rigorous engineering and evaluation of both performance and environmental impact. It not only lessens dependency on fossil fuels but also encourages healthier living and helps to slow down global warming. The Dynamo-Solar E-bicycle is proof of the ability of innovation to build a cleaner, brighter future for everybody as society continues to place a higher priority on sustainability.

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## APPENDIX

A . DATA SHEET

1. Data Sheet of Solar Pannel

| Parameter | Specification |
|---|---|
| Maximum Power (Pmax) | 3W |
| Open Circuit Voltage (Voc) | 10.8V |
| Short Circuit Current (Isc) | 0.37A |
| Rated Voltage (Vm) | 9V |
| Rated Current (Im) | 0.34A |
| Maximum System Voltage | 1000V |

2. Data Sheet of Hub Motor

| Parameter | Specification |
|---|---|
| Motor Type | Brushless DC Hub Motor (BLDC) |
| Rated Voltage | 24VDC |
| Output Power | 250W |
| Rated Speed | 3300RPM |
| Reduction Ratio | 9.78 |

3. Data Sheet of Battery

| Parameter | Specification |
|---|---|
| Battery Type | Lead - Acid Battery |
| Nominal Voltage | 12V |
| Capacity | 7.5AH |
| Maximum Charging | 1.50A |

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