Journal of
Alternate Energy
Sources & Technologies

ISSN: 2230-7982 (Online)
ISSN: 2321-5186 (Print)
Volume 15, Issue 2, 2024
May–August
DOI (Journal): 10.37591/JoAEST

https://journals.stmjournals.com/joaest

Research JoAEST

# Solar Spin: BLDC Motor Integration for Sun Powered Cycling

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***Abstract***

*This project focuses on the integration of a Brushless DC (BLDC) motor into an E-Solar Cycle to enhance its power generation efficiency. The aim is to design and implement a sustainable transportation solution that harnesses solar energy to supplement the electric power generated by the BLDC motor, thereby extending the cycle's range and reducing its dependence on external charging sources. A BLDC motor is used as the propulsion in the suggested system, which benefits from its high efficiency, low maintenance needs, and ability to precisely control speed. The integration of solar panels into the cycle's design allows for the continuous generation of electric power during daylight hours, complementing the BLDC motor's energy consumption and extending the cycle's operational range. The methodology involves the design and fabrication of the E-Solar Cycle, including the selection and integration of components such as the BLDC motor, solar panels, battery system, and control electronics. The BLDC motor is interfaced with a motor controller, which regulates its speed and torque based on input from the cycle's rider. Experimental testing and performance evaluation are conducted to assess the efficiency, reliability, and practicality of the E-Solar Cycle system under real-world conditions. Parameters such as energy consumption, range, charging time, and overall system efficiency are measured and analysed to validate the effectiveness of the integrated BLDC motor and solar power generation components. The outcome of this project is expected to be a functional E-Solar Cycle prototype capable of sustainable and efficient transportation through the integration of BLDC motor propulsion and solar power generation. The system's ability to harness renewable energy sources for propulsion contributes to reducing carbon emissions and promoting environmentally friendly transportation solutions. Furthermore, the project provides insights into the feasibility and scalability of integrating.*

**Keywords:** BLDC motor, E-Solar Cycle, generation of electric power, fossil fuel, Maximum power point tracking (MPPT)

## INTRODUCTION

The integration of renewable energy sources into transportation systems is gaining momentum worldwide as societies strive for sustainability and energy efficiency. Among these efforts, the utilization of solar power and electric propulsion systems in vehicles has emerged as a promising avenue to reduce carbon emissions and dependency on fossil fuels. This project focuses on the integration of a Brushless DC (BLDC) motor into an E-Solar Cycle, combining solar energy harvesting with electric propulsion to create a sustainable and efficient mode of transportation. The introduction of electric bicycles, or e-cycles, has revolutionized urban mobility by offering a

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Received Date: June 10, 2024
Accepted Date: June 24, 2024
Published Date: July 15, 2024

**Citation:** Kishor Jadhav. Solar Spin: BLDC Motor Integration for Sun Powered Cycling. Journal of Alternate Energy Sources & Technologies. 2024; 15(1): 30–36p.

clean, cost-effective, and convenient alternative to traditional fossil fuel-powered vehicles. These e-cycles typically rely on battery-powered electric motors for propulsion, providing users with assisted pedaling and extending their range compared to conventional bicycles. However, concerns regarding battery range limitations and the environmental impact of electricity generation persist, motivating exploration into alternative power sources and propulsion technologies.

In response to these challenges, the integration of solar power generation with electric bicycles presents an innovative solution to enhance their sustainability and autonomy. By incorporating solar panels onto the cycle's frame or components, renewable energy can be harvested during daylight hours to supplement the electric power required for propulsion. This integration not only extends the cycle's range but also reduces its reliance on external charging sources, making it more self-sufficient and environmentally friendly. The BLDC motor is chosen for its efficiency, reliability, and precise control capabilities, making it well-suited for electric propulsion applications. Its brushless design minimizes maintenance requirements while offering higher power-to-weight ratios compared to traditional brushed motors, enhancing the overall performance of the E-Solar Cycle. The integration of the BLDC motor with solar power generation components represents a holistic approach to sustainable transportation, addressing both energy consumption and generation aspects of e-cycle operation.

In this project, we aim to design, fabricate, and evaluate a prototype E-Solar Cycle equipped with a BLDC motor and solar panels. The integration of these components will be explored in detail, considering factors such as energy efficiency, system reliability, user experience, and environmental impact. Through experimental testing and performance analysis, we seek to demonstrate the feasibility and effectiveness of the integrated E-Solar Cycle concept as a practical and sustainable mode of urban transportation.

## LITERATURE REVIEW

The integration of Brushless DC (BLDC) motors into solar-powered vehicles, such as E-Solar Cycles, represents a convergence of sustainable transportation and renewable energy technologies. The following literature review provides insights into previous research and developments in this field: Solar-Powered Vehicles: Previous studies have explored various aspects of solar-powered vehicles, including design, performance optimization, and real-world applications. Researchers have investigated the integration of solar panels into vehicle structures to harness solar energy for propulsion and auxiliary systems. Case studies and experimental trials have demonstrated the feasibility of solar-powered vehicles for urban commuting and specialized applications.

### BLDC Motor Technology

Compared to conventional brushed DC motors, BLDC motors have increased efficiency, reduced maintenance needs, and enhanced dependability. Literature on BLDC motor technology covers topics such as motor design, control algorithms, and applications in electric vehicles. Researchers have developed sophisticated control strategies for BLDC motors to optimize energy efficiency, torque output, and overall performance in various operating conditions. Integration Challenges and Solutions: Integrating BLDC motors into solar-powered vehicles presents unique challenges related to power management, control integration, and system optimization. Literature in this area discusses strategies for maximizing energy efficiency by matching motor characteristics with solar power generation capabilities. Researchers have explored advanced control algorithms for coordinating power distribution between the BLDC motor, battery storage, and solar panels to achieve optimal performance and range.

### Energy Harvesting and Management

Effective energy harvesting and management are critical aspects of solar-powered vehicle design. Literature on energy harvesting techniques, such as Maximum Power Point Tracking (MPPT) for solar panels and regenerative braking for capturing kinetic energy, provides valuable insights into improving overall system efficiency. Researchers have investigated intelligent energy management systems that dynamically adjust power distribution based on real-time operating conditions to maximize energy utilization and extend vehicle range.

**Environmental and Economic Impacts**

Studies have assessed the environmental and economic benefits of solar-powered vehicles equipped with BLDC motors. Life cycle assessments and cost-benefit analyses have highlighted the potential reductions in greenhouse gas emissions, energy consumption, and operational costs compared to conventional internal combustion engine vehicles. These results highlight how crucial environmentally friendly transportation options are to reducing global warming and fostering long-term economic viability.

## METHODOLOGY

Analyze in detail the conditions and limitations of adding a BLDC motor to an E-Solar Cycle. Define performance criteria such as power output, efficiency, range, and charging time. Consider factors such as cycle weight, aerodynamics, and user interface requirements. Component Selection: Select suitable components for the BLDC motor system, including the motor itself, motor controller, battery pack, solar panels, charge controller, and any additional sensors or electronics. Ensure compatibility between components and adherence to project requirements.

Design the layout and configuration of the E-Solar Cycle, considering the integration of the BLDC motor and solar panels. Determine the optimal placement of components to maximize solar energy capture and minimize aerodynamic drag. Develop a wiring and control system architecture to facilitate communication and operation of all components. Prototype Fabrication: Fabricate a prototype of the E-Solar Cycle according to the design specifications. Install the BLDC motor, battery pack, solar panels, and associated electronics onto the cycle frame. Ensure proper mounting, wiring, and insulation to maintain safety and reliability.

Develop a control algorithm for the BLDC motor system to regulate speed, torque, and energy consumption based on user input and environmental conditions. Implement control logic to optimize energy efficiency, manage battery charging/discharging, and coordinate with the solar power generation system. Solar Power Integration: Integrate the solar panels into the cycle design, ensuring efficient capture and utilization of solar energy. Connect the solar panels to the charge controller and battery pack, implementing MPPT (Maximum Power Point Tracking) algorithms to optimize power conversion and charging efficiency.

Conduct comprehensive testing of the E-Solar Cycle prototype under various operating conditions. Evaluate the performance of the BLDC motor system, solar power generation, and overall cycle functionality. Collect data on energy consumption, range, charging efficiency, and user experience. Based on test results, determine areas that need improvement and optimization. Validate the performance and feasibility of the integrated BLDC motor and solar power system through real-world testing and user feedback. Redesign and implement the system iteratively to fix any problems or flaws found during testing. Make necessary adjustments to improve system reliability, efficiency, and user satisfaction.

Document the methodology, design process, test results, and conclusions of the E-Solar Cycle project. Prepare a comprehensive report detailing the development, implementation, and performance evaluation of the integrated BLDC motor and solar power system. Share findings and insights with stakeholders and the broader community to contribute to the advancement of sustainable transportation solutions. List of components used in this study is shown in Table 1. with specifications

**Block Diaram**

Block Diagram of flow of information is shown in Figure 1.

 

Block Diagram:

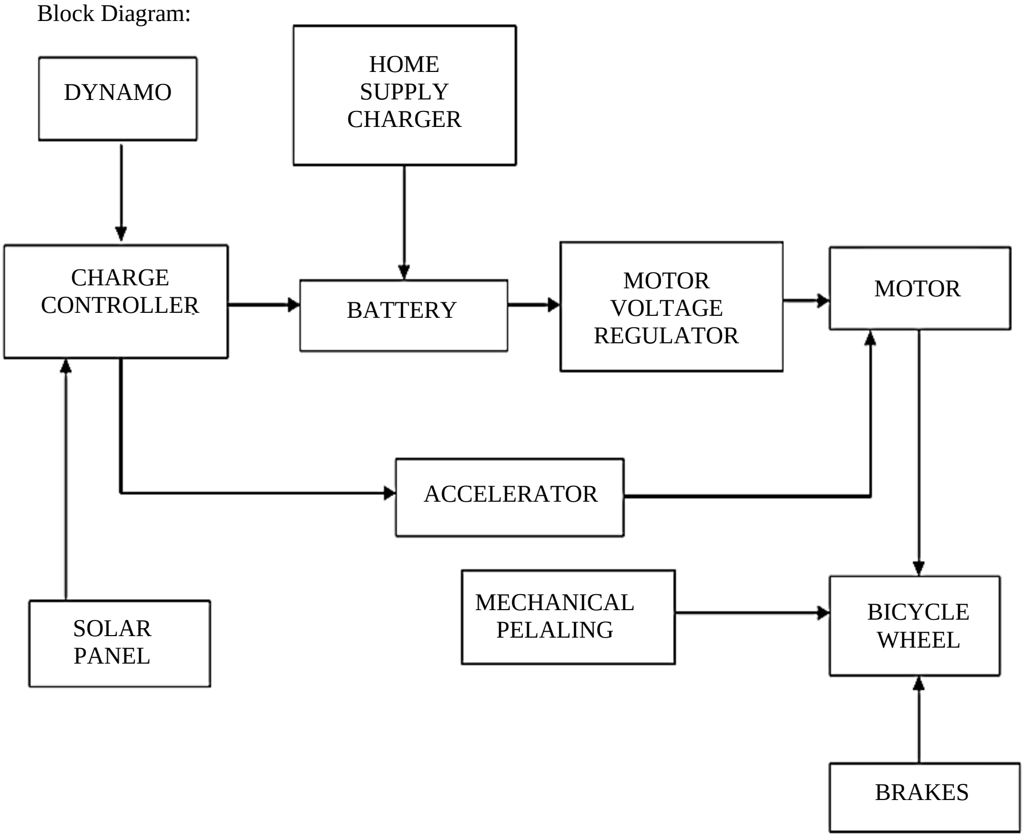


**Figure 1.** Block Diagram of flow of information.

**Table 1.** List of components with specifications.

| Sr. No. | Part Nome | Specifications. |
|---|---|---|
| 1 | Chasis | 90x40 cm |
| 2 | Seat | 30 x 20 x 10 cm |
| 3 | Wheel | 62 cm (diameter) |
| 4 | Pinion | 10 teethg |
| 5 | Sprocket | 30 teeths |
| 6 | Chain | 39. simplex roller Choin 5mm |
| 7 | DC Motor | BLDC 24V, 250W, 1500m |
| 8 | Battery | 24V. 12 Amp Lead-Acid |
| 9 | Controllers | 24V 12Amp. 250 watts |
| 10 | Solar Panel | 48V |
| 11 | Chorge controller | 48 V to 24 Y |

## CONTROLLER

A DC motor controller as shown in Figure 2. for an e-cycle regulates the speed and direction of the electric motor. It typically uses Pulse Width Modulation (PWM) techniques to control the power supplied to the motor. The controller receives input signals from the rider, such as throttle position or pedal assist level, and adjusts the motor's speed accordingly. To guard against harm to the motor or controller, it could have safety measures like temperature monitoring and overcurrent prevention. Regenerative braking, which gathers energy during braking and sends it back into the battery for enhanced efficiency, is another feature that some controllers have. All things considered, the DC motor controller is essential to e-cycles' smooth and effective power delivery, which improves both their functionality and performance. The controller receives a signal from the throttle and uses that signal to interact with the in-hub engine to modify the speed as desired. Depending on the resistance detected or the technique entered into the controller, the pedaling aid level can be manually or automatically modified, telling the motor how much assistance to provide a rider. Among the many interfaces and smart devices that can communicate with one another via the controller are the accelerator, pedal assist settings, brake systems, speed settings, and connected screens and applications. The sophistication of a controller improves with its capability.

## MOTOR

The acronym for brushless DC motor as shown in Figure 3. is BLDC. BLDC motors are direct current (DC) motors that substitute electronic commutation for brushes. Because there are no brushes on them, they are very dependable and efficient, requiring little upkeep over their extended lifespan.. BLDC motors offer smooth operation with minimal noise and electromagnetic interference. They are widely employed in many different applications, including robotics, HVAC systems, industrial automation, and electric cars, and they offer fine speed control. BLDC motors can be operated with or without sensors for rotor position feedback, allowing for sensor less or sensor-based control methods. Overall, BLDC motors are favoured for their efficiency, reliability, and versatility in modern electric and electronic systems

## BATTERY

A 12V battery as shown in Figure 4. is a common type of rechargeable battery that supplies electrical power at a nominal voltage of 12 volts. A 12V battery provides electrical energy at a voltage of 12 volts, suitable for powering a wide range of electronic devices and systems.

**Figure 2.** Controller.

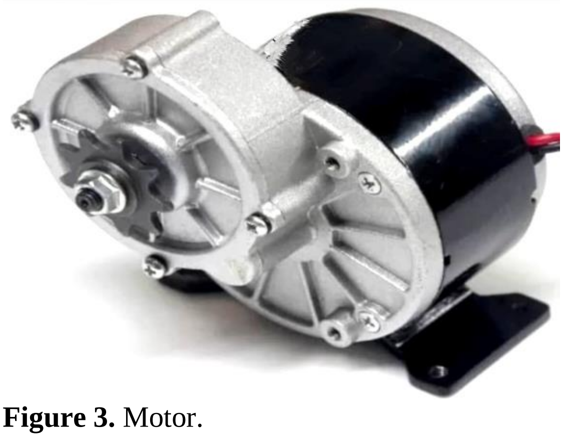

**Figure 3.** Motor.

 


**Figure 4.** Battery.

It can be constructed using various chemistries, such as lead-acid, lithium-ion, or nickel-metal hydride, each with its own characteristics in terms of energy density, weight, and cycle life.12V batteries are widely used in automotive applications for starting engines, as well as in marine, RV, and off-grid solar systems. They also power smaller devices like portable electronics, power tools, and emergency lighting.

## RESULTS & DISCUSSION

The BLDC motor is an ideal choice for powering an E-Cycle due to its extended lifespan compared to other motors, thanks to the absence of brushes. Additionally, it boasts high starting torque, a crucial factor in accelerating the Cycle to high no-load speeds with minimal energy consumption. The mechanical power output of the BLDC motor can approach 90% of the entire electrical power input, with efficiency rates as high as 85 to 90%. Characteristics of torque is shown in Figure 5. in the form of wave type graph.

When observing the parameters in action to produce torque, the nominal voltage parameter of 1-volt results in a rotor speed of 10.65 RPM for operating the BLDC motor in order to obtain the torque characteristics.

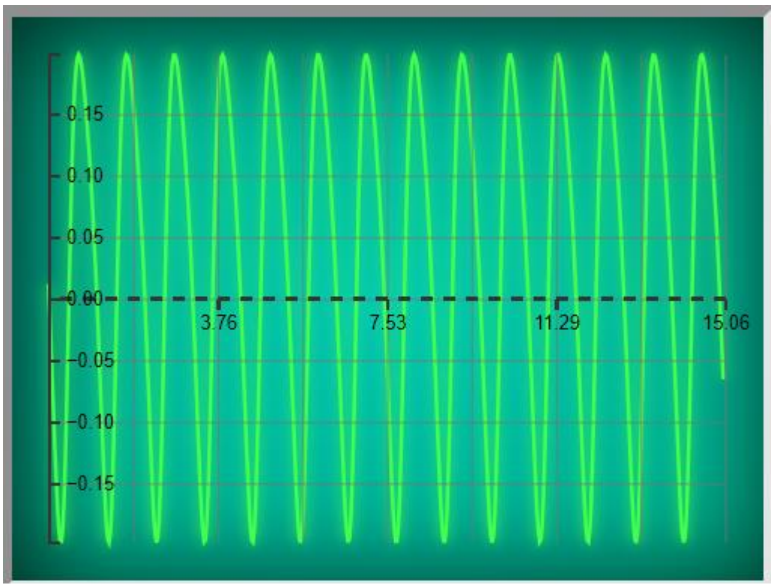


**Figure 5.** Torque characteristics.

## CONCLUSION

In conclusion, the integration of a Brushless DC (BLDC) motor into an electric cycle (e-cycle) offers numerous benefits, including enhanced efficiency, reliability, and performance. BLDC motors are ideal for e-cycle propulsion because they offer smooth and accurate control over speed and torque. Additionally, their brushless design reduces maintenance requirements and extends the lifespan of the motor. By powering the e-cycle with a BLDC motor, users can enjoy a more enjoyable and eco-friendly riding experience while reducing dependence on fossil fuels. Overall, the combination of BLDC motor technology and e-cycle design represents a promising solution for sustainable urban transportation.

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