# Solar Electric Vehicle with Backup Battery

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**Abstract:**

The rising need for eco-friendly transportation has driven the innovation of solar electric vehicles (SEVs) equipped with auxiliary battery systems. This project aims to develop a solar-powered electric vehicle featuring photovoltaic (PV) panels and a backup battery to improve efficiency and extend driving range. The PV panels capture solar energy, transforming it into electricity to run the vehicle's motor and recharge the onboard battery. The backup battery ensures uninterrupted operation during nighttime or low sunlight conditions, enhancing reliability and minimizing reliance on external charging sources. An advanced power management system efficiently allocates energy between the solar panels, battery, and motor to optimize performance. Additionally, regenerative braking is incorporated to further improve energy efficiency. An intelligent energy monitoring system is also integrated, allowing real-time tracking of power consumption and charging levels to optimize energy distribution. This innovative approach aims to lower carbon emissions, encourage the use of renewable energy, and enhance the vehicle's range by utilizing a hybrid energy system. **[1]**

**Keywords:** Arduino, Solar, Battery, Vehicle

## Introduction:

With the rapid surge in pollution levels, there is an urgent need to explore alternative ways to generate power for homes, vehicles, and industries. This necessity has grown significantly in recent years due to the increasing concerns about the depletion of fossil fuel reserves and the severe environmental and social consequences associated with their consumption. The rapid exhaustion of crude oil reserves has been primarily driven by the surge in fuel demand, especially within the automobile sector. As a result, there has been a shift in focus toward electric vehicles as a means to mitigate harmful emissions and promote cleaner transportation solutions.

However, electric vehicles come with their own set of challenges. One major drawback is their dependency on the electric grid, which already faces significant strain in many regions due to energy shortages. In countries where power deficits are a concern, relying solely on electric vehicles is not currently a feasible option. Additionally, while electric vehicles are perceived as environmentally friendly, they are not entirely emission-free. If the electricity used to charge their batteries is derived from fossil fuels, pollution is still generated at power plants, contributing to environmental degradation. Thus, rather than eliminating pollution entirely, electric vehicles merely redistribute and decentralize it, reducing emissions at the vehicle level while shifting the burden to power generation facilities.

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**Methodology:**

The Figure 1 shows block diagram of system having an internal combustion engine and one or more electric motors, which draw power from batteries, power solar-powered electric cars. The battery of an electric car powered by solar energy cannot be charged by plugging it in. Rather, the internal combustion engine and regenerative braking are used to charge the battery. We supply an Arduino for system control in this setup. When our electric car starts, two motors rotate The first, followed by another pair of motors that rotate and generate power, which is stored in the second battery. On the other hand, we switch the batteries using separate switches. Additionally, a buzzer is used here to show the battery voltages.

The buzzer and LED will turn on to signal that the battery is low if the voltage is less than 9 volts. Additionally, while the engine is stopped, the battery can power auxiliary loads and minimize engine idling. By using solar energy to power its electric drivetrain, a Solar Electric Vehicle (SEV) lessens dependency on fossil fuels and encourages the use of cleaner, more environmentally friendly forms of transportation. Solar panels, which are usually installed on the top of the car, are the first part of the system. They use photovoltaic cells to transform sunlight into electrical energy. A charge controller, which has a Maximum Power Point Tracker (MPPT), receives this energy.

By adapting to shifting sunshine conditions, the MPPT makes sure the solar panels run as efficiently as possible. When sunlight is insufficient, the energy produced is then stored in a high-capacity battery, often a lithium-ion type, which serves as the primary power source.

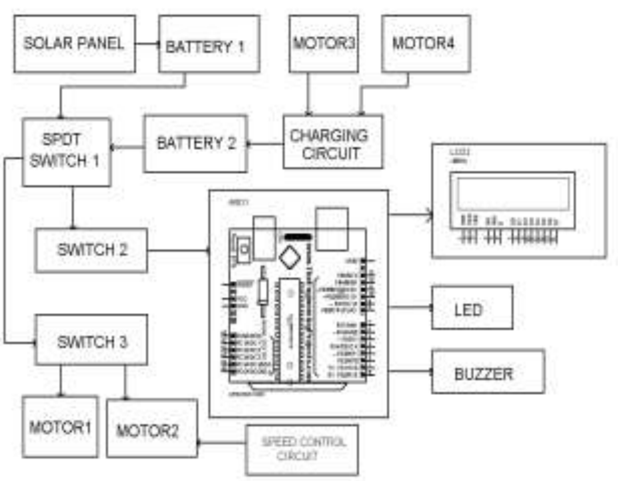


*Figure 1. Block Diagram of System*

Maintaining battery health, keeping an eye on temperature, voltage, and charge levels, and avoiding problems like deep discharge or overcharging all depend on the Battery Management System (BMS). The electric motor, a component of the electric drive system, is powered by the battery. To move the vehicle's wheels, the motor transforms electrical energy into mechanical power. In order to ensure smooth acceleration and deceleration, a motor controller controls the power delivered to the motor based on input from the driver.

All of these systems are coordinated by the Vehicle Control Unit (VCU), which makes choices in real time to maximize energy efficiency and guarantee safe operation. It modifies how electricity is distributed among the solar panels, battery, and motor. Auxiliary systems that run on solar or battery power are also included in the SEV, including entertainment, air conditioning, and lighting. When solar energy is not enough, the car may also feature an external charging input that allows it to be charged from an outside power source. The SEV is an extremely effective and eco-friendly substitute for conventional automobiles because of its integrated system.

Without using bullet points, let's examine the complex operations of this figure, breaking down each element and its function inside the system. The intricate electrical system depicted in the diagram is either a prototype or instructional demonstration intended to highlight how an Arduino microcontroller integrates solar power, battery management, motor control, and many feedback methods. [4]

**Result Discussion ;**

1. **Solar Energy Utilization:** PV panels efficiently transformed sunlight into electrical power, albeit their effectiveness varied according to the amount of sunlight.

2. **Battery Backup Performance:** By storing extra energy, the backup battery ensured uninterrupted functioning at night or in low sunlight

3. **Power Management System:** Optimized performance and battery health through effective energy allocation among solar panels, battery and motor. s

4. **Regenerative Braking:** This technique effectively restored kinetic energy, increasing batter life and reducing power use.

5. **Vehicle Performance & Range:** The hybrid system worked well in a variety of weather conditions and increased driving range.
6. For increased efficiency, an energy monitoring system tracked battery health and energy usage in real time.
7. Decreased Grid Dependency: It was mostly powered by solar energy, which made it appropriate for off-grid uses.

**Future Scope:**

1. **Better Solar Panels**: Flexible, lightweight, and more efficient PV cells produce more power.
2. **Advanced Batteries:** Solid-state or graphene-based batteries are used to extend battery life and speed up charging.
3. AI-powered solutions for efficient energy distribution and usage forecasting are known as smart energy management.
4. **Wireless & Fast Charging:** The creation of fast battery charging and wireless solar charging stations.
5. **IoT & Smart Monitoring:** Integration of mobile apps for remote monitoring and real-time energy tracking.
6. **Lightweight and Aerodynamic Design:** Carbon fiber is used, and vehicle forms are optimized for increased efficiency.
7. Hybrid energy systems combine wind, sun, kinetic recovery, and regenerative braking.

## Conclusion ;

The solar-powered electric vehicle, which combines regenerative braking and solar charging, is designed and tested to offer a pollution-free substitute for cars powered by internal combustion engines (ICs). One was charged using an MPPT charge controller unit. A 120W, 18.6V solar panel is used to power a 12V, 80Ah battery. Regenerative power can be supplied to the vehicle's linked auxiliary equipment through the usage of a DC generator for regenerative braking. However, the system's hefty initial cost is its main drawback. It will become more practical and efficient with additional advancements in battery charge measurement and faster charging methods.

By fusing solar energy with electric mobility, solar electric vehicles (SEVs) provide a promising development in environmentally friendly transportation that will lessen reliance on fossil fuels and cut greenhouse gas emissions. Direct integration of solar panels into the vehicle to capture renewable energy, increasing their efficiency and self-sufficiency. The development of solar electric vehicles (SEVs) highlights how they have the potential to completely transform the automotive sector by providing a cost-effective, environmentally responsible, and sustainable substitute for traditional automobiles. By combining solar panels with electric drivetrains, SEVs enable cars to use renewable solar energy for longer range and less reliance on infrastructure for charging. [5]

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