Solar and Wind Power Electric Vehicle

M Rekha[1*], *K* Akshith[1], J Varun Sai[1], *P* Srividya Devi[1], *G* Revathi[1], *Ramee* Hussaien

[1]Department of EEE, Gokaraju Rangaraju Institute of Engineering and Technology, Hyderabad, Telangana, India
[2]Department of Refrigeration and air Conditioning Techniques engineering, College of technical Engineering, The Islamic University, Najaf, Iraq.

Abstract. This project concerns a vehicle, the "Solar and Wind Power Electrical Vehicle," whose operation is controlled using IoT. The principal purpose is to use renewable forces for vehicle movement. There is an ESP32 microcontroller that connects to two electric engines and a motor driver enabling precise commands in the structure. Furthermore, the car consists of a solar battery panel and a wind turbine providing sustainable and ecological energy production. Our main objective is to build a car that uses no oil or gas at all since it can run on something more unconventional, such as solar power, wind energy, etc.; thus, the focus of this project is on creating a green car that will not use fuel made from fossil fuels like petrol or diesel while making sure that it works using only sustainable sources of energy available today. The motor driving system integrates the ESP32 module into the motor speed adjustment circuit (MSAC), which acts as an electronic hub for both motor control signals and serial communication codes between the motor and the CPU (central processing unit) on a single chip. Remote car control using just your phone is possible because IoT connects it. When connected, the driver can have control over each motor's direction individually such that they are interconnected with the two motors by default on the driver circuit board (or the relation may occur by default). Consequently, the vehicle gets an increased capacity for navigating various surfaces more effectively this way—The two engines act as an independent supposing of its configuration. If you want it to move off the road or even on hilly ground, this car would do so easily because there is a mechanism that makes it easier for her to move on such surfaces. It is equipped with a solar panel and wind turbine, allowing the car to be powered by renewable energy from its environment. During the day, the sun charging system converts sunlight into electricity, whereas during the night the wind generator creates power from wind when there is some wind. The stored energy can be preserved in accumulators.

1 Introduction

The" Solar and Wind Power Electrical Vehicle" project is a groundbreaking development that appears in a world where the majority of people are now thinking about sustainable and eco-friendly solutions. This project highlights an IoT-controlled car that is in sync with nature where the sun's rays and wind are used as means of moving from one place to another [2].

[*] Corresponding Author: rmudundi@gmail.com

The central focus of this undertaking is the incorporation of state-of-the-art technology, with an ESP32 microcontroller. It connects flawlessly to two motors and a motor driver altogether [1]. The merging of these elements creates an effective system for governing operations effectively and conveniently for producing an eco-friendly means of transport.

This project has one goal: it creates an electric car without having to depend on oil or coal consumption, but utilizing alternative energy like sun or wind power instead [10]. To do that, you need to use the ESP32 for controlling all engines as well as communication among them. It also enables the Internet of Things (IoT) which makes it possible for customers to control such a car using their phones while they could stay at any location [3]. Variety and Suddenness stand out as key features of the design of the project. One motor is closely associated with the driver whereby it can be controlled in its directions without being affected by the other. By adopting this setup, the car becomes very easy to maneuver through challenging surfaces as a result of increased efficiency.
This project is unique for using renewable energy – a solar panel and a wind turbine. Aside from representing eco-friendliness in the car, the said components are also functional power sources [7]. The solar panel captures energy during the day, and the wind turbine utilizes the wind to rotate. In this manner of operation, energy is acquired and preserved in an electric battery efficiently, making it a reliable and environmentally friendly power source for vehicles (10)

2 Block Diagram

A solar and wind-powered electric vehicle would normally have an elaborate but operational block diagram which is shown in Figure 1 incorporating many essential parts:

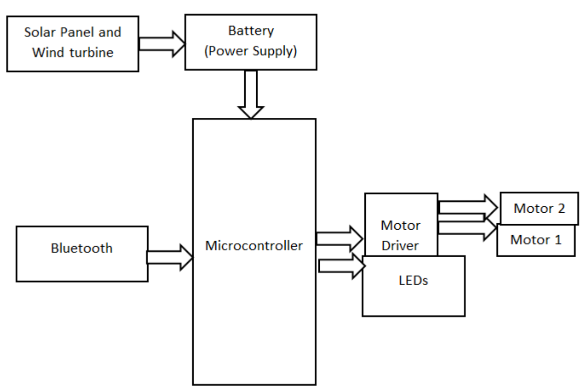

Fig. 1. Block Diagram of Solar and Wind Power Electric Vehicle

Solar Panels: These devices transform sunlight into electrical energy, serving as the vehicle's primary power source. *Wind Turbines:* Utilizing wind energy, these turbines generate electricity to contribute to the overall power supply for the electric vehicle. *Power Management System:* This essential component regulates and optimizes the incoming solar and wind energy, ensuring efficient utilization within the vehicle. *Electric Motor/Drive System:* Responsible for converting electrical energy into mechanical energy, the electric motor and drive system propels the vehicle forward.

2.1 Operating Principle

Using embedded systems in electric vehicles, specifically in the "Solar and Wind Power Electrical Vehicle." This system integrates an ESP32 microcontroller with two motors and a motor driver to improve control and energy efficiency. It allows for seamless communication through IoT, enabling remote control from a smartphone. By incorporating renewable energy sources like solar panels and wind turbines, the vehicle reduces dependency on non-renewable fuels and ensures a sustainable power supply.

3 Modelling of PV array and Wind Turbine

3.1 PV Model

Table 1 includes Short circuit current, Open circuit Voltage, Current at Pmax, Voltage at Pmax, and Number of modules connected in series.

Table 1. Block parameters of the PV Model

Short circuit current	8.01
Open circuit Voltage	36.90
Current at Pmax	7.10
Voltage at Pmax	30.3
Series – Connected modules connected per String	5
Parallel Strings	20
Cells per Module (Ncell)	14

3.2 Mathematical Modeling of Wind Turbine

The equation below provides the expression for the mechanical output power derived from the wind turbine:

Pm=0.5.Cp(λ, β).p.A.V^3 (1)

Where

V=is the wind speed

P=is the air Density(ρ=1.225kg/m^3)

Cp=power coefficient

A = the rotor's swept area in the wind turbine.

The power coefficient in theory is Cp=0.593, but in practical applications, wind turbines often exhibit values well below this theoretical limit. Commonly, even in well-designed wind turbines, actual power coefficients range from 0.35 to 0.45, significantly below the theoretical beta limit.

With λ defined as

1/ λ = 1/ β + 0.08θ − 0.035/1 + θ3 (2)

The tip speed λ is defined: λ = wm R/v

Wm=rotor's angular velocity

R=turbine's radius

The rotor torque is given in the equation:

Tw=Pm/wm (3)

Table 2 includes the tip speed ratio(λ), wind turbine's performance coefficient Cp(λ, β), and wind speed(m/s) (V).

Table 2. Specifications for wind turbine

λ	8.1
Cp(λ, β)	0.41
V	12m/sec
R	3.877
ρ	1.225kg/m^2
C1, C2, C3, C4, C5, C6	0.5,116,0.4,0,5,21

4 Simulation Results

4.1 EV Battery Charging using PV Array

Fig 2 represents the simulation circuit of the PV array used to charge the battery. A boost converter has been employed to increase the voltage level to charge the battery.

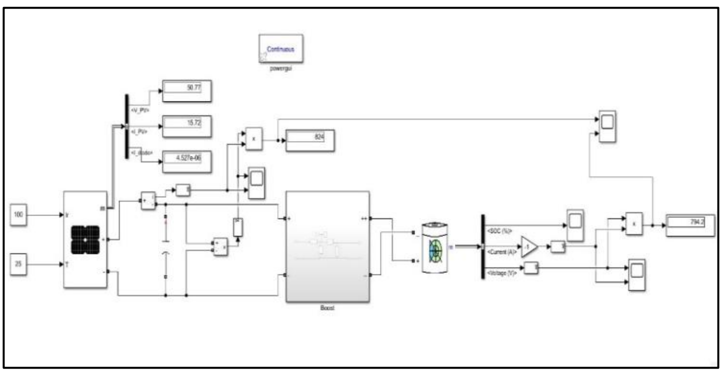

Fig. 2. PV Array Simulation Circuit

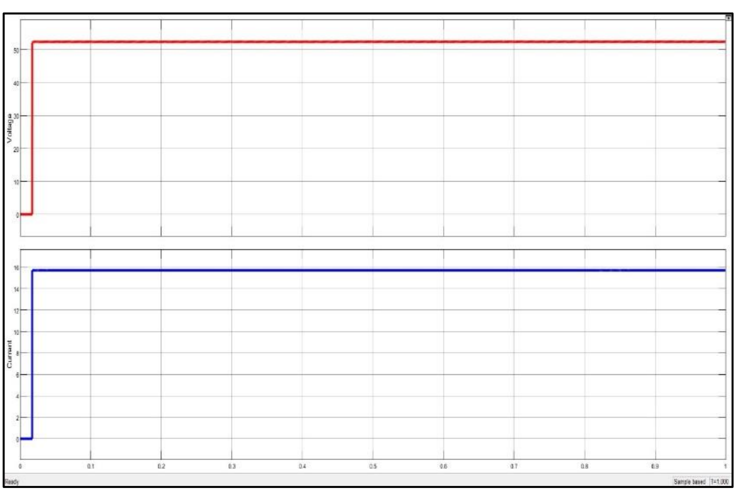

Fig. 3. Solar Output Voltage and Current

Figure 3 represents the output voltage and current waveforms of the PV Array. The output voltage of the PV array is about 52.4 volts. The output current of the PV array is 15.71 Amps. Figure 4 represents the boost converter simulation circuit. As the input from the PV Array is less, the voltage level increased to charge the battery. Figure 5 represents the output voltage and current waveforms of the battery. The output voltage of the battery is about 103 volts. The output current of the battery is 7.71 Amps. Figure 6 represents the State of Charge (SOC), it is observed that it is increasing linearly. Figure 7 represents the output waveform of power. The input power is about 824 watts. The output power is about 794.4 watts.

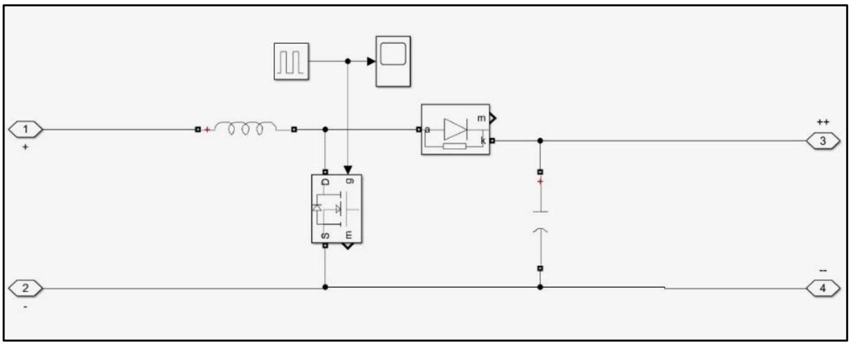

Fig. 4. Boost Converter

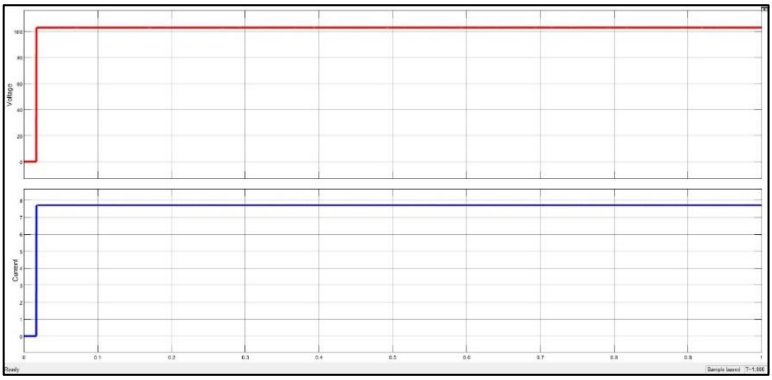

Fig. 5. Battery Voltage and Current

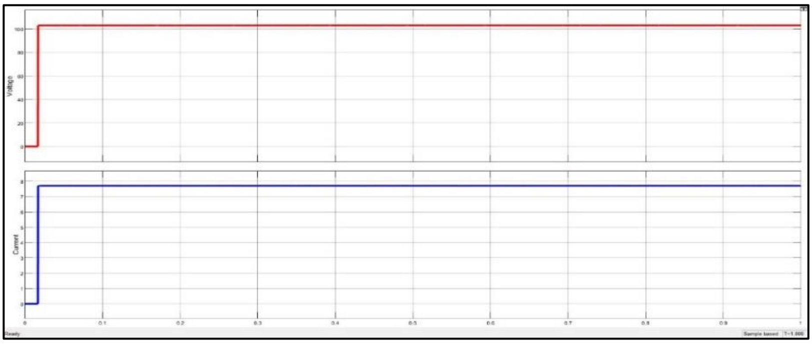

Fig. 6. Battery Voltage and Current

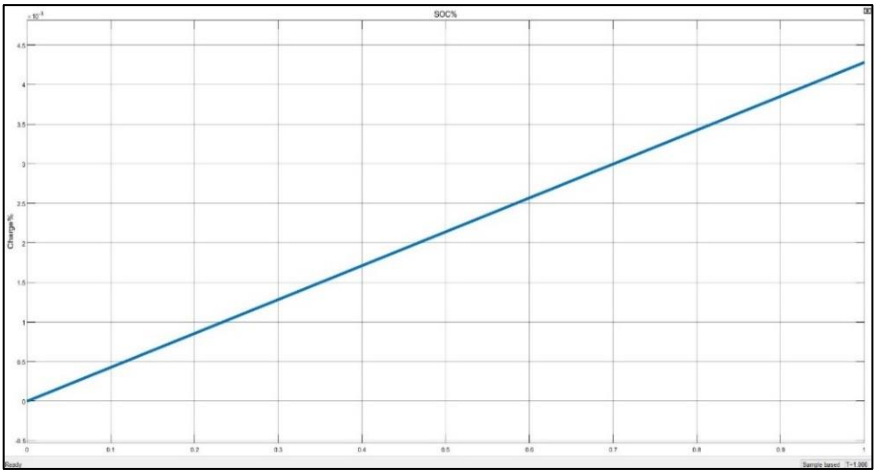

Fig. 7. Battery State of Charge

4.2 EV Battery Charging using Wind Turbine

Figure 8 illustrates the process of EV battery charging using a wind turbine. The energy generated from the wind is supplied to the rectifier and then to the boost converter, which is used to charge the battery. Figure 9 represents the output voltage and current waveforms of the rectifier. The output voltage of a wind turbine is about 52 Volts.The output current of wind is 5 Amps. Figure 10 represents the battery output voltage and current. The output voltage is about 103 volts. The output current is about 2.29 Amps. Figure 11 illustrates the State of Charge (SOC) of the battery. The state of charge increases steadily over time. Figure 12 represents the input power and output power waveforms. The input power is about 260 watts. The output power is about 234.4 watts.

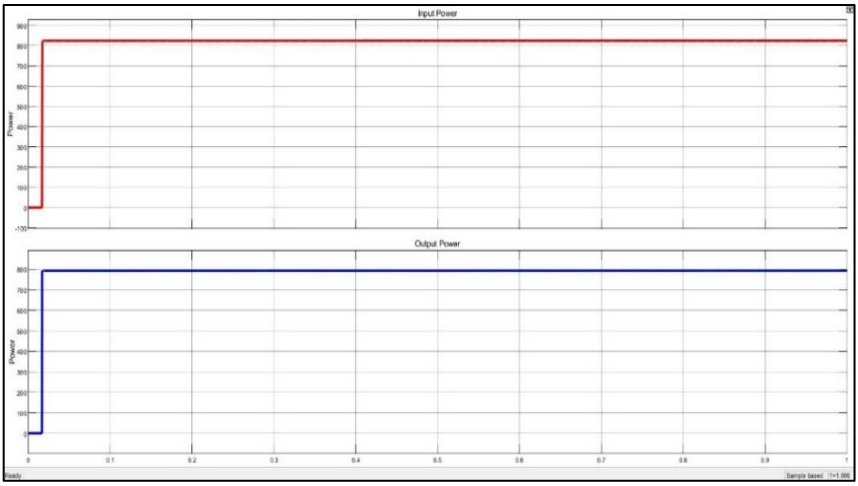

Fig. 8. Solar Input and Output Power Waveforms

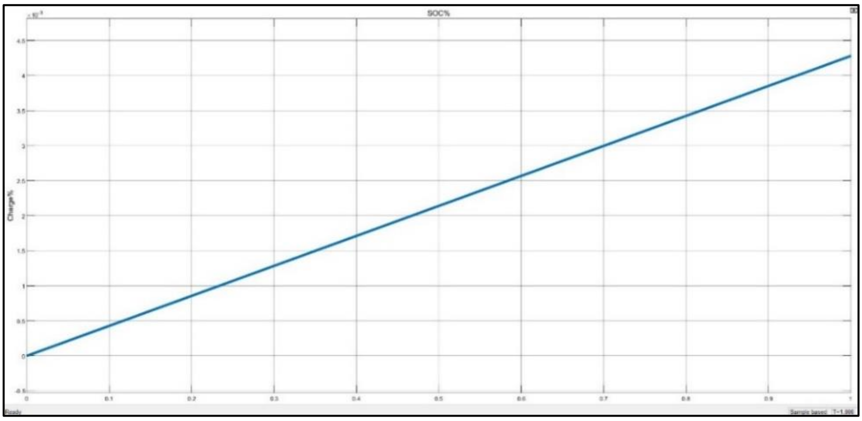

Fig. 9. Battery State of Charge

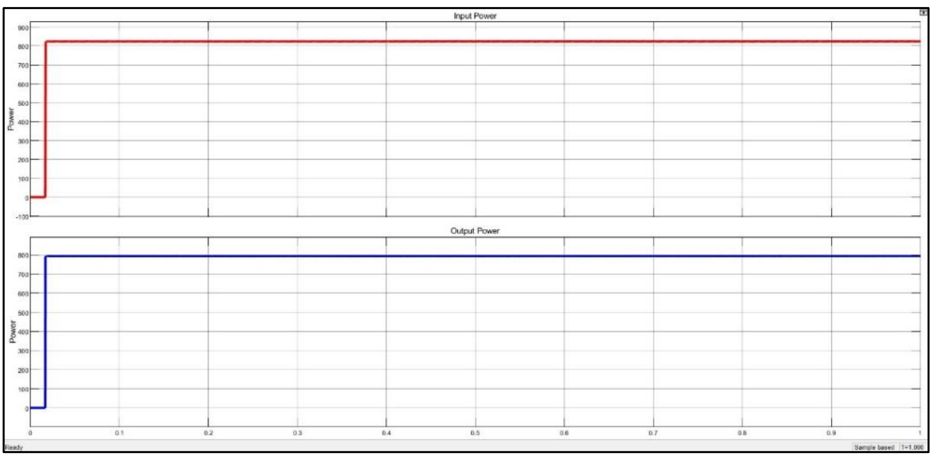

Fig. 10. Input and Output Power Waveforms of the battery

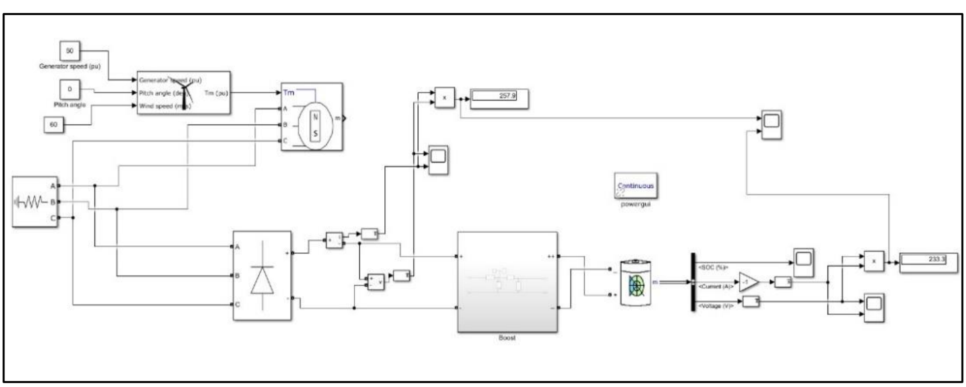

Fig. 11. Wind Turbine power circuit current

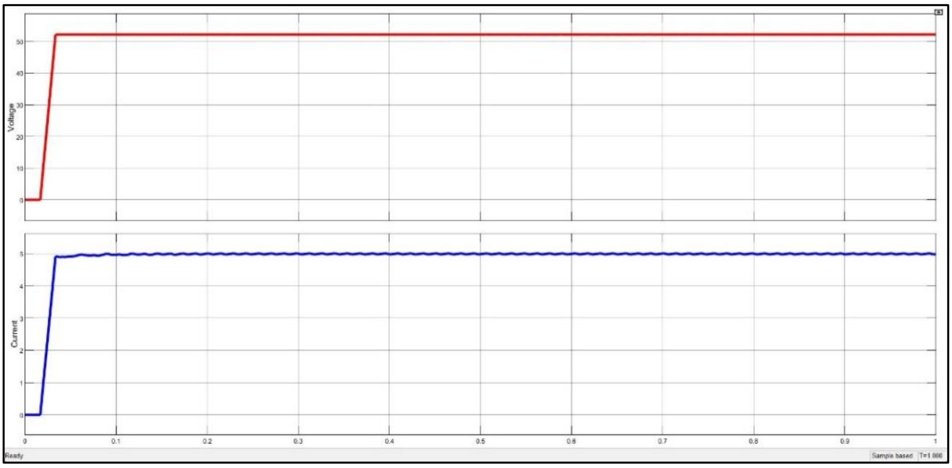

Fig. 12. Rectifier Output Voltage and Current

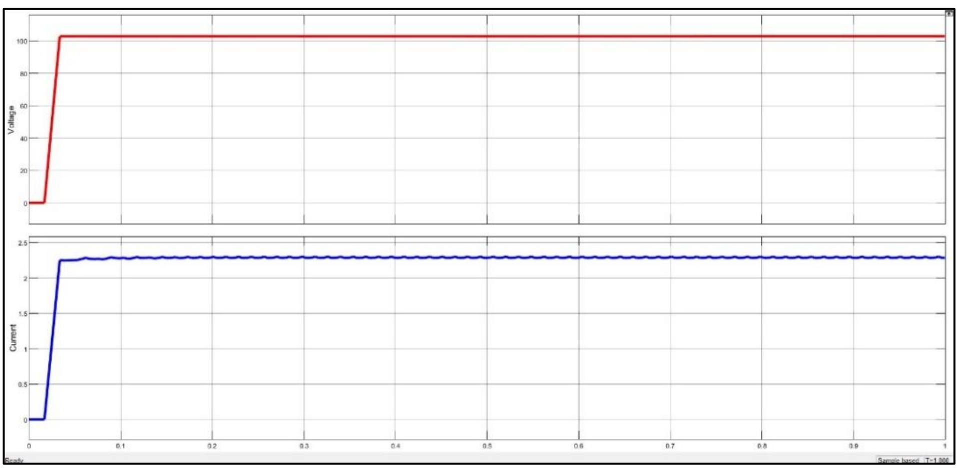

Fig. 13. Battery Output Voltage and Current

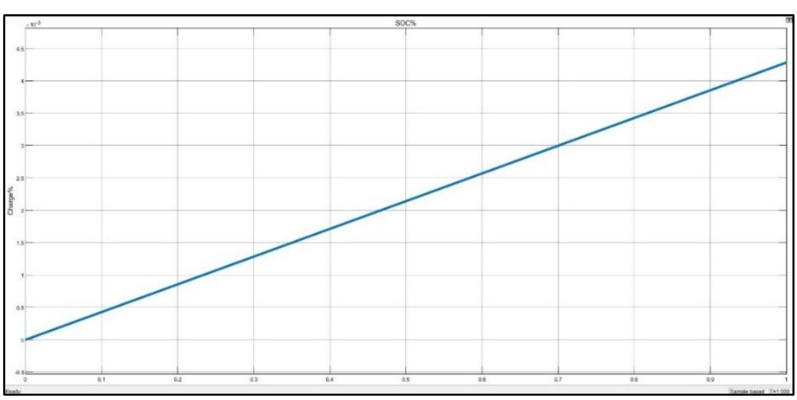

Fig. 14. Battery State of Charge

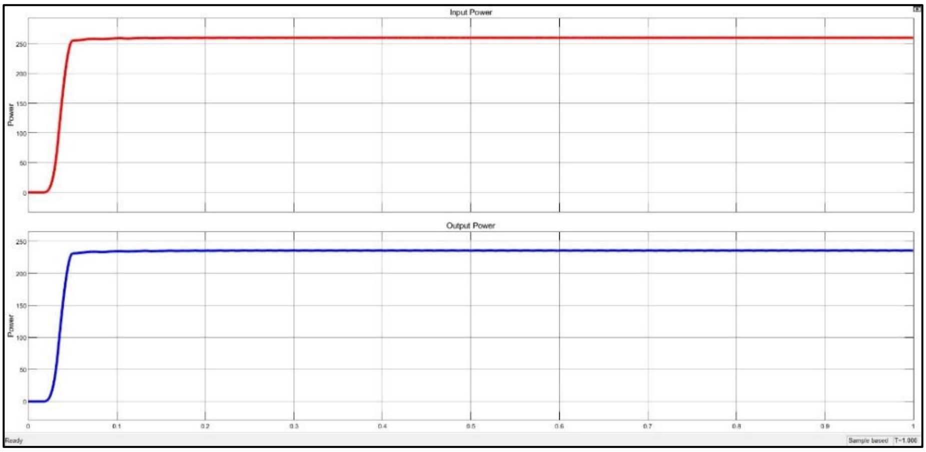

Fig. 15. Input and Output Power Waveforms

5 Prototype

Figure 16 depicts the prototype of the project. Adafruit.io is an interface for controlling the motor, offering four directional options: forward, backward, left, and right. This hardware model includes a solar panel and wind motor to charge the battery. The battery is used to supply power to the ESP32 and motor driver, which controls the motor directions. Figure17 represents the Adafruit IO interface, which controls the motor direction using a mobile device. With the four controlling buttons vehicle can be controlled in the di left, right, forward and backward directions.

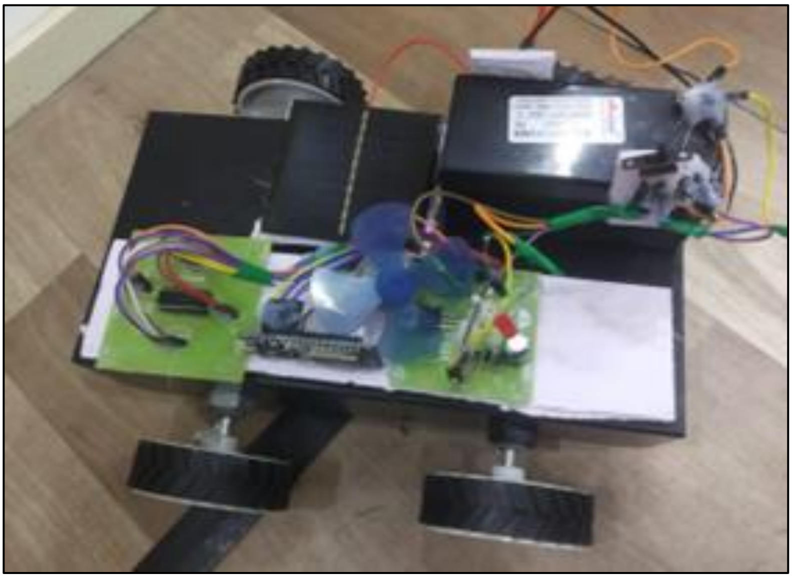

Fig. 16. Hardware Prototype model

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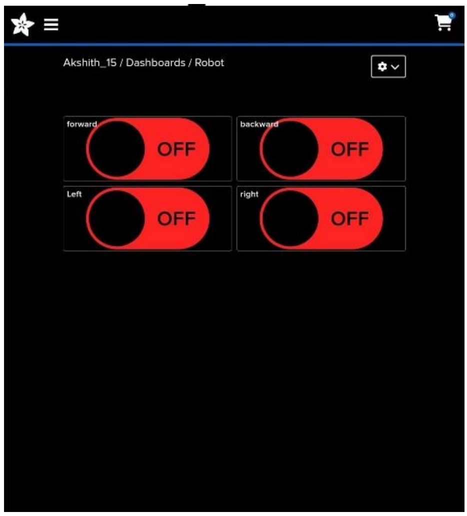

Fig. 17. Adafruit.io Interface

6 Conclusion

The "Solar and Wind Power Electrical Vehicle" project demonstrates the potential of eco-conscious technology and sustainable transportation by integrating renewable energy sources, advanced IoT connectivity, and innovative design. The primary goal was to create an eco-friendly electrical vehicle that reduces dependence on conventional energy sources. It harnesses solar and wind power, exemplifying clean energy and sustainability. The vehicle's design features solar panels, a wind turbine, and energy storage, ensuring a reliable power supply. Additionally, using an ESP32 microcontroller and IoT connectivity enables seamless remote control via a smartphone. This project reflects a commitment to sustainable living, showcasing the potential of renewable energy sources and their intelligent integration into daily lives, reducing carbon footprint and preserving the environment for future generations.

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