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Electric Vehicle To Local Load To Run Parking With Iot Based Monitoring System

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ABSTRACT

This project presents an IoT-enabled, low-cost Vehicle-to-Local load (V2L) system using the ESP32 microcontroller, designed to utilize electric vehicles (EVs) as both energy consumers and distributed energy storage units. The system automatically switches between charging the EV from the grid and discharging stored energy back to the grid during power outages, ensuring uninterrupted supply. A reverse parking detection mechanism enables seamless connection, while sensors, relays, and an inverter manage AC-DC conversion under ESP32 control. Real-time monitoring is provided via an LCD and IoT dashboard. This setup offers an affordable and sustainable alternative to traditional backup systems, improving energy utilization and grid resilience. Despite challenges like battery wear and regulatory constraints, the system demonstrates strong potential for integration with renewable energy sources, AI-based control, and community microgrids—paving the way for smarter, cleaner, and more efficient energy management in the future.

Keyword: Electric Vehicle (EV), Internet of Things (IoT), Inverter, ESP32, Solar Panel, Single Pole Double Throw Relay (SPDT), Battery, Converter, Resistor

1. INTRODUCTION

The twenty-first century has witnessed an unprecedented transformation in the global transportation and energy sectors, driven largely by the rapid adoption of electric vehicles (EVs) and the growing urgency to transition toward sustainable energy systems. Electric vehicles, once considered niche or futuristic, are now becoming mainstream due to advances in battery technology, decreasing costs of renewable energy generation, stricter emission regulations, and increasing consumer awareness about climate change. Governments around the world are setting ambitious targets for EV penetration, with several countries announcing plans to phase out internal combustion engine (ICE) vehicles entirely within the coming decades. This transition brings with it not only environmental and economic benefits but also significant challenges in terms of energy supply, infrastructure, and system integration. At the centre of this transformation lies the concept of **Vehicle-to-Local load (V2L)**

technology, which envisions EVs not merely as energy consumers but also as dynamic energy storage units that can interact intelligently with the electric grid.

Globally, the number of EVs on the road is growing exponentially. According to the International Energy Agency (IEA), there were over 26 million EVs worldwide by 2022, and this number is projected to exceed 200 million by 2030 if current policies and market trends continue. Each EV is essentially a mobile energy storage unit, equipped with batteries ranging from 30 kWh to more than 100 kWh of capacity. For context, the average daily electricity consumption of a household in many regions is between 8 to 15 kWh, meaning a single EV battery could theoretically power a home for several days. However, despite this immense potential, the vast majority of EVs remain underutilized in terms of their energy storage capabilities. Vehicles are typically driven for less than two hours per day, meaning their batteries remain idle for over 90% of the time. During these idle hours, especially when parked at home or at workplaces, EVs could provide valuable services to the electric grid or act as emergency backup sources for households and businesses.

This project arises from a combination of energy resilience needs, economic opportunities, and sustainability goals. In many regions, power outages remain a common problem, whether due to natural disasters, technical failures, or grid overload. For households and businesses, such outages can cause significant inconvenience and economic loss. Traditional backup solutions, such as diesel generators or inverters with dedicated batteries, are either environmentally harmful, noisy, and fuel-dependent or costly in terms of installation and maintenance. EV-to-grid systems present a cleaner, more cost-effective alternative. Since EVs are already purchased for transportation, using their batteries for secondary purposes like backup power incurs little additional capital cost.

In this paper [1] preference we studied Method of Vehicle-to-grid (V2G) Concepts and Grid Integration.
In this paper [2] preference we studied Smart Charging, Scheduling and Battery-Discharge Strategies.
In this paper [3] preference we studied Embedded System, IoT Monitoring and Communication Standards.
In this paper [4] preference we studied Small-Scale and Parking Slot Implementation.

2. PROPOSED METHOD

The main objective of this project is to study the IoT based monitoring system use for parking to design a low-cost EV-to-grid system using the ESP32 microcontroller as the central controller. Implementing the EV battery charges from the grid when supply is available and discharges to provide backup power when the grid is down. Also, implement reverse parking integration for automated mechanism and design monitoring and control system for ensuring transparency and user convenience.

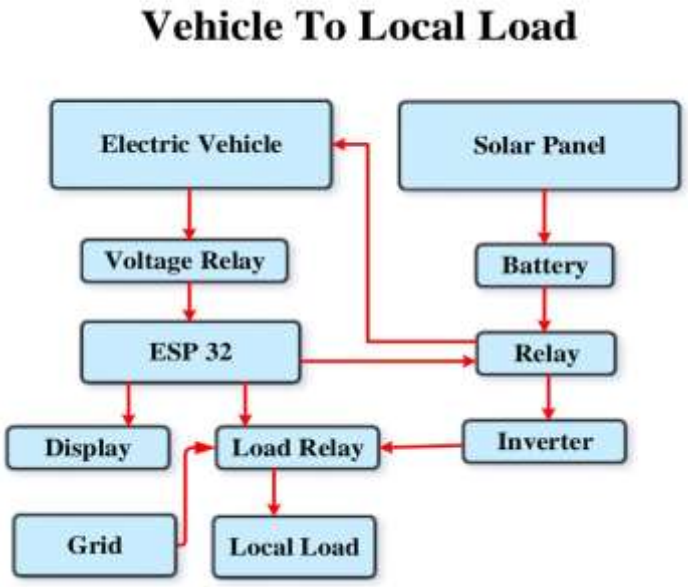

Fig No.1 Shows the arrangement of Proposed Method

3. HARDWARE IMPLEMENTATION OF THE PROPOSED METHOD

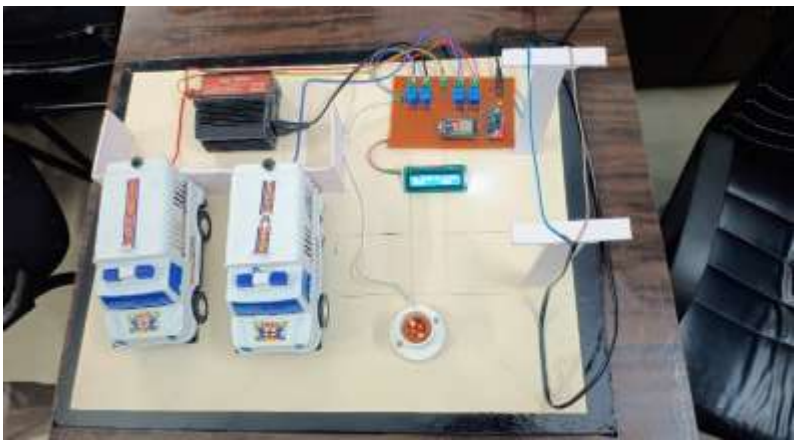

Fig No.2 Hardware Implementation of the Proposed Method

COMPONENTS	RATING	SPECIFICATION
Solar Panel	20W	A solar panel is a device that converts sunlight into10 electricity using photovoltaic (PV) cells made of semiconductor materials like silicon.
ESP32	ESP32 3.3V to 5V	The ESP32 is a series of low-cost, low-power microcontrollers developed by Espressif Systems that integrate both Wi-Fi and Bluetooth connectivity on a single System-on-a-Chip (SoC).
Inverter	Square Wave 200W	An inverter is an electronic device that converts direct current (DC) to alternating current (AC). This process is vital for powering most household appliances.
Relay	SPDT DC 5V	A SPDT relay (Single Pole Double Throw) is an electrical switch that uses a single input common13terminal to connect to one of two different output terminals.
Battery	12Volt. 2Amp	A battery is an electrochemical device that converts stored chemical energy into electrical energy to power portable electronic devices.
Resistor	10 ohm & 100 ohm	A resistor is a passive electronic component designed to impede the flow of electric current in a circuit.
Converter	LM2596 12V to 5V	A converter is any device that transforms energy or35signals from one form to another, most commonly referring to an electrical device that changes the characteristics of electricity, such as voltage, current , OUT or type (AC to DC, DC to AC).
LCD	16/2	A 16x2 LCD is a common type of character Liquid Crystal Display module used in DIY electronics and embedded systems. It is named for its ability to display 16 characters per line across two lines, for a This is a 2x16total of 32 characters.

4. Result and Conclusion

The project has delivered a functioning prototype of an IoT-enabled energy management system for two emergency parking slots, integrating solar charging, dual-battery storage, relay-based switching, inverter load supply, grid fallback, LCD display and web logging. The literature review confirmed that while V2G and smart charging systems are the subject of intense research, there remains a niche for compact embedded implementations that integrate solar, battery, grid fallback and IoT monitoring at the parking slot scale. The system design incorporates the core modules: solar panel with charge controller, battery bank with voltage sensing, ESP32 controller (powered via buck-converter) managing relays and logging, inverter and AC load, and grid fallback path. The working description details the role of each subsystem and their interaction via the control logic.

Fig No.3 Grid Mode On

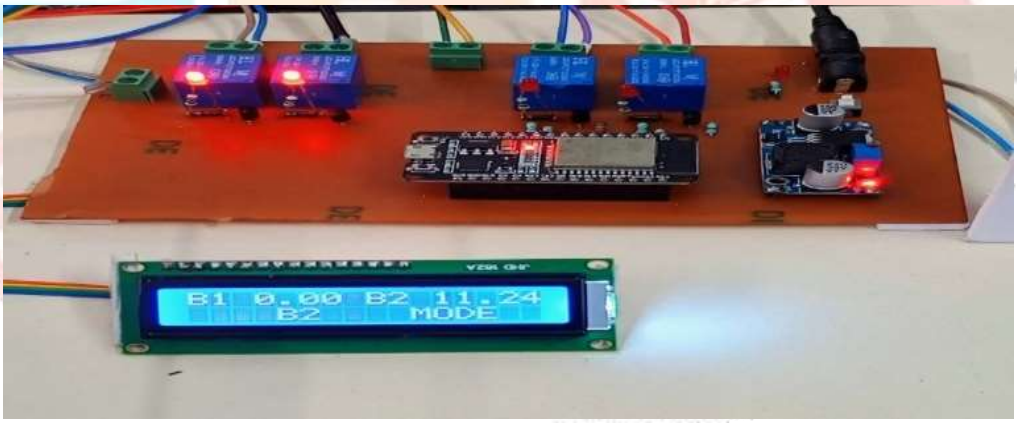

Fig No.4 Only B2(Vehicle) is Connected

Fig No.5 Both Vehicle (B1 and B2) is Connected

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