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Self-Sustaining AI-Optimized Electric Vehicle a Multi-Source Energy Regeneration and AI-Driven Power Management Approach

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ABSTRACT: Electric Vehicles (EVs) are becoming more and more popular, which has increased demand for sustainable mobility solutions and effective energy utilization. This study introduces an innovative approach to multi-source energy regeneration and Artificial Intelligence (AI)-driven power management for EVs. It presents a sustainable energy system that integrates Renewable Energy Sources (RES), primarily solar power, to enhance energy harvesting and boost the self-sufficiency of EVs. A key aspect of this framework is an AI-powered battery management system, which intelligently controls the Battery Energy Storage System (BESS) to optimize energy consumption in real time. Additionally, the proposed solution incorporates an automatic battery swapping mechanism within a dual-battery architecture. One battery actively powers the vehicle while the other undergoes charging, ensuring uninterrupted operation. AI algorithms analyse historical and real-time data to predict battery lifespan, regulate charge cycles, and improve energy efficiency. Cloud-based data storage facilitates predictive maintenance, reducing downtime and enhancing overall system reliability. Experimental simulations and prototype testing demonstrate that this AI-driven power management system enhances energy efficiency by 96%, minimizes dependence on external charging infrastructure, and supports long-term environmental sustainability. By integrating AI with advanced battery management, the system paves the way for more sustainable, autonomous, and intelligent EV operations, revolutionizing the future of electric mobility.

Keywords: Electric Vehicles, Multi-source energy regeneration, Artificial Intelligence, Power management, Battery, Cloud-based data storage.

1. Introduction

The transportation industry is a major source of global carbon emissions, emphasizing the urgency of adopting cleaner and more sustainable solutions. EV's offer a viable alternative to mitigate environmental damage and reduce reliance on fossil fuels. However, their widespread success relies on robust charging infrastructure, seamless grid integration, and efficient Energy Management Systems (EMS) to enhance performance and to optimize energy utilization. Efficient energy management in EV's are essential for optimizing power distribution, improving vehicle performance, and reducing energy losses [1-2]. It also plays a crucial role in advancing broader sustainability goals, including alleviating grid stress and seamlessly integrating RES into the system. The primary goals of these strategies are to enhance overall efficiency and ensure the seamless functioning of the vehicle's power system. Key goals include reducing power loss, stabilizing voltage levels, minimizing peak loads, and lowering energy costs [3].

Battery storage systems are becoming increasingly vital for maintaining grid stability, especially as inverter-based RES replace conventional synchronous generators. Among these, residential battery storage systems are gaining significant attention due to their relatively low upfront costs and versatile applications in home energy management [4-5]. However, the efficient operation of these systems presents notable challenges, as their performance and utility are highly dependent on user-specific consumption patterns and real-time energy needs. Effective management requires advanced control strategies that dynamically adapt to fluctuating demand, generation variability, and grid conditions to ensure optimal energy usage, cost savings, and system reliability [6]. EVs embedding AI-driven power management systems, modern EVs efficiently manage and optimize energy flow between regenerative sources, storage units, and consumption modules. These AI-powered systems contribute to making EVs increasingly autonomous and self-sustaining by learning user behaviour, optimizing charging and discharging cycles, and dynamically adjusting power allocation based on environmental and operational factors [7]. Despite existing advances, challenges remain in handling diverse energy forms and unpredictable load behaviours. However, the fusion of AI with energy regeneration especially in systems presents promising directions for forecasting, load management and resource optimization [8-9].

By proposing a self-sustaining energy framework for EVs that combines multi-source energy regeneration with sophisticated AI-driven power control, the study described here solves the drawbacks of current EV energy charging systems. The recommended method uses AI algorithms to automatically control and optimize power distribution in real-time using a solar energy source [10-11]. The AI system makes sure that the energy is allocated and stored efficiently, preventing power shortages and optimizing overall efficiency by examining automobile dynamics, environmental factors, and energy usage patterns. This framework also incorporates adaptive energy routing strategies that enhance system resilience and reduce dependence on external charging infrastructure. [12] Special emphasis is placed on the seamless integration of energy harvesting modules and intelligent controllers to accommodate evolving vehicle configurations and driving scenarios. This coordinated approach not only strengthens energy autonomy and operational reliability but also ensures long-term sustainability.

2. Recent Works

Ferreira *et al* (2025) [13] have developed integration of EVs and AI in last-mile delivery has gained considerable attention in enhancing the sustainability in urban logistics. It involves simulation-based modelling and real-time route optimization using AI algorithms such as Machine Learning (ML) and reinforcement learning. These approaches enable dynamic route planning based on variables like traffic patterns, delivery urgency, energy consumption and vehicle range. It offers lower operating expenses and carbon emissions while enhancing service dependability and delivery efficiency. Nevertheless, due to high initial cost and technological complexity of EV, fleet deployment and maintenance, especially for small and medium-sized businesses are some of the major issues. Additionally, challenges related to battery limitations and charging infrastructure remain persistent.

Shern *et al* (2024) [14] have introduced a Smart Grid (SG) technology have increasingly focused on integrating AI into EV charging systems to enhance energy efficiency and user-centric service delivery. Real-time demand response and energy distribution techniques that optimize charging schedules, lessen grid pressure, and save energy expenditures are made possible by these predictive insights. By reducing peak-time energy use and improving load balancing, this strategy increase the electric grid's overall sustainability and dependability. Moreover, predictive optimization allows charging systems to adapt dynamically to user needs and environmental conditions. However, it lies in the requirement for large-scale data collection and the risk of user privacy concerns, as well as the computational intensity of real-time AI processing.

Badhoutiya *et al* (2024) [15] have demonstrated an AI to fuel cell optimization in EVs as a transformative strategy in enhancing energy efficiency and operational reliability. These models are trained on real-time and historical data are utilized to predict system behaviour and make adaptive adjustments that maximize output power and extend the lifespan of fuel cells. By minimizing performance deterioration brought on by operational stress and less-than-ideal conditions, this strategy has the potential to greatly increase fuel cell efficiency and durability. AI systems also make predictive maintenance easier, which lowers maintenance expenses and downtime. The difficulty of incorporating AI algorithms into current vehicle control systems, however, necessitates specific hardware and software infrastructure, increasing the overall cost of development.

Mehta *et al* (2025) [16] have proposed an integration of AI in the design and solar energy management of EVs has gained increasing prominence as a means to boost energy efficiency and sustainability. AI is employed to manage real-time energy flow from solar panels to batteries by predicting solar input, driving conditions, and power demands. It provides is its ability to significantly extend vehicle range and reduce dependency on grid-based charging by leveraging renewable energy effectively. Moreover, AI facilitates adaptive energy management that responds dynamically to environmental and operational variables. However, it is the variability of solar energy availability, which limits the system reliability in regions with inconsistent sunlight.

Carter *et al* (2023) [17] have presented an integration of AI in energy storage systems has become key focus in enhancing the efficiency and reliability of renewable energy utilization. The use of AI algorithms such as neural networks, reinforcement learning, and predictive analytics for optimizing the performance of BESS in conjunction with variable renewable sources like solar and wind. It provides real-time monitoring and forecasting of energy generation, consumption patterns and battery health to intelligently manage charging and discharging cycles. This approach is its ability to improve energy availability and grid stability by minimizing energy losses and balancing supply-demand fluctuations effectively. However, a major limitation is that model training relies on large-scale, high-quality datasets, which limits performance. The key contributions are:

- To design and implement a complete multi-source energy regeneration system that combines solar energy sources to continuously recharge the battery of an electric vehicle while it is in motion.
- To maximize use of on-board energy generating and storage capabilities in order to reduce dependency on external charging infrastructure.
- To enhance the energy attained from the RES based solar energy system, booster circuit is employed.
- To optimize battery management and regulate charging/discharging conditions, BMS is integrated
- To effectively control the motor operations, controlled propulsion and drive the EV system, motor driver is equipped.
- To establish into operation a power management system powered by AI that monitor and optimize energy flow in real time based on factors including driving

habits, the state of the environment, and battery health metrics.

- To improve overall energy economy and battery life by using adaptive prioritization of available energy sources, dynamic power routing, and intelligent load balancing.

3. Proposed System Description

Power management and effective energy regeneration have become crucial areas of focus due to the increased complexity of EV systems and the rising demand for sustainable energy solutions. As the EV design incorporate solar energy based RES, the conventional energy management techniques are no longer enough. In order to overcome these obstacles, contemporary EVs are currently implementing AI-optimized methods for energy flow control and distribution in real time. These sophisticated systems also helps to track, forecast, and optimize power consumption, resulting in increased energy efficiency and longer battery life.

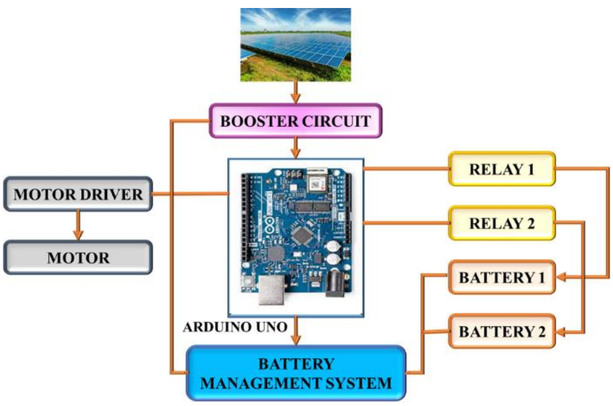

Figure 1: *Proposed Block Diagram*

Figure 1 shows an intelligent, self-sufficient EV energy management system that combines battery optimization, power control elements, and sustainable energy sources. The primary energy contributor of this EV is solar power. The energy attained from the solar panels is low and inconsistent, it is essential to step-up the power. A booster circuit enhances the voltage to a level that used to power and charge the components. A microcontroller, which serves as the central control unit, is in center of the setup. The boosted energy is then routed to the microcontroller for intelligent distribution. The microprocessor is linked to two relays (Relay 1 and Relay 2), which act as electrical switches to regulate the energy flow to two different batteries (Battery 1 and Battery 2). Based on demand and charge levels, the system makes sure that energy is managed and distributed across these batteries in the best possible way. Solar panels constantly recharge the batteries, ensuring continuous operation without relying on external charging sources. The motor driver, which in turn regulates the motor and moves the electric car forward, is powered by these batteries. The AI-driven power management effectively switches between solar and battery power while optimizing battery charging cycles and motor performance.

4. System Modelling

4.1 Solar Panel

The primary energy source of this EV system is the solar photovoltaic source. In a PV system, a solar array is made up of many solar cells that, when exposed to sunlight, produce charge carriers. The sunlight absorbed from the solar panels are effectively converted into electrical energy to power-up the motor. In Figure 2, the schematic circuit of PV systems is displayed that includes intrinsic shunt and series resistances, denoted as R_p and R_s respectively.

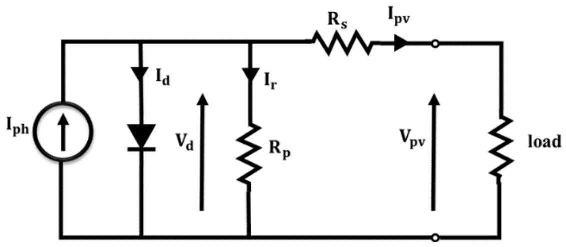

Figure 2: *Circuit Diagram of PV Panel*

The output current (I_{PV}) and voltage (V_{PV}) of the solar array are also represented. The electrical model is simplified by considering R_p as significantly large and R_s as minimal.

$$I = I_{ph} - I_S\left[exp\left(\frac{qV_{PV}}{K_bTA}\right) - 1\right] \quad (1)$$

The photo current is computed as,

$$I_{ph} = \left(\frac{G}{G_n}\right)\left[I_{sc(ref)} + \alpha\left(T_c - T_{ref}\right)\right] \quad (2)$$

The solar irradiance is G and nominal irradiance is G_n. $I_{sc(ref)}$ is short circuit current at reference temperature is T_r, temperature co-efficient is α, temperature of the cell is T_c and reference temperature is T_{ref}.

The saturation current (I_d) is expressed as,

$$I_d = I_{dr}\left(\frac{T}{T_r}\right)^3 exp\left[\frac{q}{K_b T A}\left(1 - \frac{T}{T_r}\right)\right] \quad (3)$$

The Boltzmann constant is K_b, electron charge is q and A is the ideality factor.

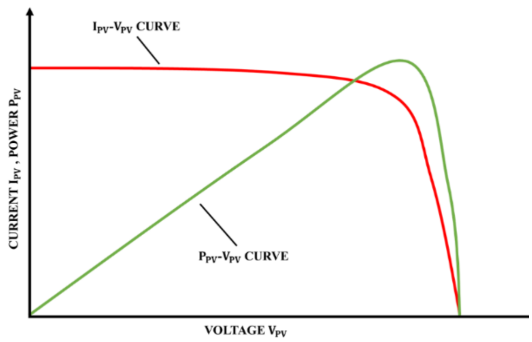

Figure 3: *Characteristics Curve of PV System*

Figure 3 presented illustrates the characteristic curves of a PV cell, specifically the current-voltage (I < sub > PV </sub > −V < sub > PV </sub >) and power-voltage (P < sub > PV </sub > −V < sub > PV </sub >) relationships. These curves are crucial in understanding and optimizing the performance of solar panels. The energy generated from the PV system is used to charge the battery and drive the motor.

4.2 Battery Management System

Components of this energy chain correspond to key components of a Battery Management System (BMS). Charger is commonly referred to as Power Module (PM). This power module not only charges battery but also delivers power directly to load as needed. A typical BMS system consists of power module, a battery, a DC/DC converter, and linked load. BMS's essential intelligence stems from its capacity to properly monitor and control these components. This includes monitoring metrics like voltage, current, temperature, and status of charge.

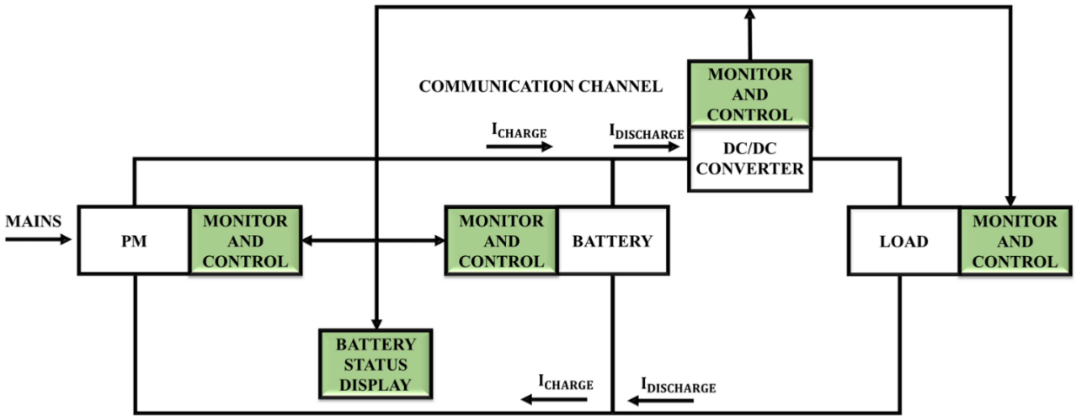

Figure 4: *Control of BMS*

When no external current flows, battery is in equilibrium, with reaction rates of electrode reactions listed below. Nernst's equation yields equilibrium potential E^{eq} of each electrode.

$$\mathrm{E}_{+}^{\mathrm{eq}} = \mathrm{E}_{+}^{\mathrm{o}} + \frac{\mathrm{RT}}{\mathrm{nF}}\ln\frac{\left(\mathrm{a}_{\mathrm{Ox}_{+}}\right)^{\mathrm{B}}}{\left(\mathrm{a}_{\mathrm{Red}_{+}}\right)^{\mathrm{A}}} \quad (4)$$

For the positive electrode and

$$\mathrm{E}_{-}^{\mathrm{eq}} = \mathrm{E}_{-}^{\mathrm{o}} + \frac{\mathrm{RT}}{\mathrm{mF}}\ln\frac{\left(\mathrm{a}_{\mathrm{Ox}_{-}}\right)^{\mathrm{C}}}{\left(\mathrm{a}_{\mathrm{Red}_{-}}\right)^{\mathrm{D}}} \quad (5)$$

The full battery's equilibrium potential is found using the following expression:

$$\mathrm{E}_{\mathrm{bat}}^{\mathrm{eq}} = \mathrm{E}_{+}^{\mathrm{eq}} - \mathrm{E}_{-}^{\mathrm{eq}} = \mathrm{E}_{+}^{\mathrm{o}} - \mathrm{E}_{-}^{\mathrm{o}} + \frac{\mathrm{RT}}{\mathrm{nF}}\ln\frac{\left(\mathrm{a}_{\mathrm{Ox}_{+}}\right)^{\mathrm{B}}\left(\mathrm{a}_{\mathrm{Red}_{-}}\right)^{\mathrm{D}}}{\left(\mathrm{a}_{\mathrm{Red}_{+}}\right)^{\mathrm{A}}\left(\mathrm{a}_{\mathrm{Ox}_{-}}\right)^{\mathrm{C}}} \quad (6)$$

Again, $n = m$ is given for simplicity. Above equation indicates that value of a battery's equilibrium potential is determined by ratio of activities of oxidized and reduced species in its two electrodes. As a result, equilibrium potential is determined by State-of-Charge (SoC) of two electrodes and, by extension, SoC of the battery. Thus, BMS effectively monitors and controls battery's charging and discharging processes, assuring reliability and long-term survival.

4.3 Motor

A DC motor is an electromechanical device that transforms Direct Current (DC) electrical energy into mechanical motion. It operates based on the principle of electromagnetic force. When a DC voltage is supplied to the motor, it generates rotational movement, making it ideal for applications requiring accurate control of speed and torque. DC motors are widely utilized in EV, robotics, household appliances, and various industrial automation systems. A DC motor's fundamental components are stator, rotor or armature, commutator, brushes, and windings. Stator is made up of permanent magnets or electromagnets that generate magnetic fields. Rotor, which is positioned on a shaft, houses windings that transport current. Brushes make contact with commutator, ensuring that electricity flows continuously to rotating windings. Interaction of magnetic field with electric current in windings generates torque, which causes rotor to rotate.

Motor's high power density implies that even when its size is lowered, it still produces a substantial amount of power. Formula below describes link between output power and speed:

$$P_w = 2\pi n \cdot T_e \tag{7}$$

In the formula, P_w is motor output power in kW, n is the motor speed in rpm, and T_e is motor output torque in Nm.

The above mentioned relation expresses how motor power is proportional to torque. If torque density expression is obtained, power density is calculated using same or equivalent rotational speeds. According to electrical machine fundamental design theory, increasing motor speed while preserving output torque improves output power.

$$\frac{D_i^2 l_{ef}\, n}{P_w} = \frac{6.1}{\propto_p K_\omega A B_\delta} \tag{8}$$

Armature diameter D_i in mm, effective axial length l_{ef} in mm, pole arc coefficient $\propto_p$, winding coefficient K_w, air gap flux density peak value B_δ in T, stator linear current density (A/m), and expression for A are as follows:

$$A = \frac{2 I_s N m}{\pi D_i} \tag{9}$$

$$\rho_e = \frac{\propto_p K_\omega 2 m N J_c S_{copper} B_\delta n}{6.1\, \pi D_i} \tag{10}$$

Where $\rho_e$power density in kW/kg motor is, m is phase number, N is number of conductors in slot and I_s is stator phase current RMS value in A. The motor operation is controlled by the Arduino, which adjusts power based on AI algorithms to optimize speed, direction, and energy efficiency while integrating regenerative braking for improved performance and sustainability.

4.4 Relay

A relay is an electromechanical device that switches high-power circuits based on a low-power control signal. It serves as an interface between low-voltage electronic systems such as microcontrollers and higher-powered electrical components like motors, lighting systems, or home appliances. Relays are particularly valuable in situations where the control circuit and the load circuit operate at different voltage or current levels, providing effective electrical isolation between the two. The core components of a relay include an electromagnet, an armature, electrical contacts and a return spring. When voltage is applied to coil, it produces a magnetic field that attracts armature, causing relay’s contacts to either close or open depending on design. This switching action either completes or interrupts the circuit connected to the load.

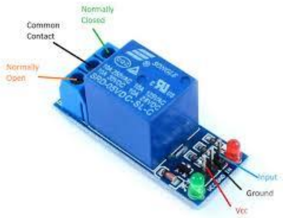

Figure 5: *Relay*

In this approach there are 2 relays (Relay 1 and Relay 2) are employed that effectively switches between the power sources and regulate batteries (Battery 1 and Battery 2) charging/discharging operations. This enables the system to prioritize the usage of solar energy when available while switching to battery power when necessary. It also allows the system to balance the charge levels of the two batteries, resulting in peak performance and lifespan.

4.5 Arduino Uno

Arduino UNO is a widely used open-source microcontroller board, popular in electronics, automation, and robotics projects. Built around the ATmega328P microcontroller, it is ideal for both beginners and experienced developers due to its simplicity, reliability, and strong community support. The board powered through a USB connection or an external power supply ranging from 7 to 12 volts. Programming the Arduino UNO is done through the Arduino IDE (Integrated Development Environment), which uses a simplified version of C/C++. Users write code, known as sketches, which are then uploaded to the board via USB. Once uploaded, the Arduino continuously executes the program until it is reset or powered off.

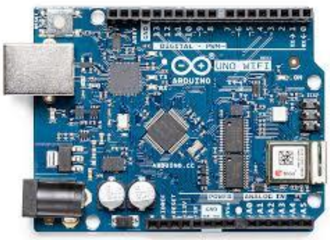

Figure 6: *Arduino Microcontroller*

Arduino microcontroller serves as system's brain, processing sensor inputs and executing programmed instructions to control components like as motors, relays. It optimizes energy distribution by regulating battery charging, switching between power sources, and assuring optimal operation using AI-powered algorithms.

5. Result and Discussion

The prototype of the Self-Sustaining AI-Optimized Electric Vehicle efficiently integrates solar charging, battery backup, and regenerative braking with AI-based power management. During testing, the AI autonomously selected energy sources based on light and battery status, optimizing usage. Solar panels increased operational time by 20–25%, and regenerative braking aided energy recovery.

Figure 7: *Hardware Setup*

The prototype shown in the Figure 7 represents a scaled model of a self-sustaining EV, integrated with multi-source energy regeneration and AI-driven power management capabilities. The vehicle harnesses energy from multiple sources, including a solar panel for supplemental charging, an internal battery pack for storing energy during low solar input, and a regenerative braking system that recovers energy during deceleration. The system ensures seamless operation by properly integrating microcontrollers, voltage and current sensors, and energy sources. This allows the vehicle to respond dynamically to program inputs, maintaining stable movement and optimized charging behaviour under varying conditions.

Table 1: *Comparison of Efficiency*

SL. NO	REFERENCES	EFFICIENCY
1.	Waleed F. Faris *et al* [8]	95%
2.	Qi Shen *et al* [18]	95.3%
3.	Proposed	96%

Table 1 shows the different types of techniques compared based on AI-driven power management capabilities and the proposed prototype is demonstrated as the better efficiency of 96%. The table highlights the progressive improvements in energy regeneration and power management for AI-optimized electric vehicles. The proposed approach achieves the highest efficiency at 96%, surpassing previous methods that reached 95% and 95.3%. The enhancement in efficiency helps improve vehicle performance, extend operational range, and reduce energy consumption, making AI-based optimization a valuable tool for sustainable electric mobility.

5. Conclusion

A comprehensive and forward-thinking solution is presented to address the growing energy demands associated with the widespread adoption of EVs. By introducing a multi-source energy regeneration system that harnesses RES based solar energy harvesting combined with an AI-driven power management approach, the study offers a practical path toward enhancing the energy self-sufficiency and operational efficiency of EVs. The intelligent allocation and optimization of energy resources, guided by real-time data and predictive algorithms, not only minimize energy wastage but also extend vehicle range and improve battery health management. The findings from simulations and prototype evaluations validate the system's potential and the efficiency of 96% to reduce reliance on traditional charging infrastructure and contribute meaningfully to sustainable mobility goals.

References

1. Hari Prasad Bhupathi, Srikiran Chinta, Year: 2024, "AI-Powered Efficiency Machine Learning Techniques for EV Battery Charging", ESP International Journal of Advancements in Science & Technology (ESP-IJAST), Vol: 2, No: 3, pp. 64-73.

2. Vinodkumar Devarajan, Year: 2025, "Revolutionizing Energy Management: The Impact of AI and Machine Learning Technologies", Journal of Computer Science and Technology Studies, Vol: 7, No: 3, pp. 327-333.

3. Sanaz Taghizad Farahmand, Year: 2025, "AI-Driven Urban Traffic Optimization: A Case Study of Tehran's Metropolitan Traffic Management System", In 8th International Conference on Civil Engineering, Architecture and Urban Planning With An Approach to Urban Infrastructure Development, Barcelona, Spain.

4. Venkata Narasareddy Annapareddy, Year: 2024, "Harnessing AI Neural Networks and Generative AI for Optimized Solar Energy Production and Residential Battery Storage Management", Available at SSRN 5203702.

5. Anwar Hossain, Mohd Abdullah Al Mamun, Kaosar Hossain, Hamza Bin Habibur Rahman, Hassan M. Al-Jawahry, M. M. H. Melon, Year: 2024, "AI-Driven Optimization and Management of Decentralized Renewable Energy Grids", Nanotechnology Perceptions, pp. 76-97.

6. Iqbal Husain, Burak Ozpineci, Md Sariful Islam, Emre Gurpinar, Gui-Jia Su, Wensong Yu, Shajjad Chowdhury, Lincoln Xue, Dhrubo Rahman, Raj Sahu, Year: 2021, "Electric drive technology trends, challenges, and opportunities for future electric vehicles", Proceedings of the IEEE, Vol: 109, No: 6, pp. 1039-1059.

7. Katsiaryna Bahamazava, year: 2025, "AI-driven scenarios for urban mobility: Quantifying the role of

ODE models and scenario planning in reducing traffic congestion", Transport Economics and Management, No: 3, pp. 92-103.

8. Waleed F. Faris, Year: 2024, "Intelligent Load Balancing in Microgrids with AI Optimization", Research Journal of Computer Systems and Engineering, Vol: 5, No: 1, pp. 83-94.

9. Maria Enrica Zamponi, Enrico Barbierato, Year: 2022, "The dual role of artificial intelligence in developing smart cities", Smart Cities, Vol: 5, No: 2, pp. 728-755.

10. Shumail Sahibzada, Farrukh Sher Malik, Sheharyar Nasir, Shahrukh Khan Lodhi, Year: 2025, "Generative AI Driven Aerodynamic Shape Optimization: A Neural Network-Based Framework for Enhancing Performance and Efficiency".

11. Jessica Obianuju Ojadi, Chinekwu Somtochukwu Odionu, Ekene Cynthia Onukwulu, Olumide Akindele Owulade, Year: 2024, "AI-Enabled Smart Grid Systems for Energy Efficiency and Carbon Footprint Reduction in Urban Energy Networks", International Journal of Multidisciplinary Research and Growth Evaluation, Vol: 5, No: 1, pp. 1549-1566.

12. Akram Elentably, "Leveraging Artificial Intelligence to reduce the carbon footprint of the Saudi commercial shipping industry", Global Scientific and Academic Research Journal of Economics, Business and Management ISSN: 2583-5645 (Online), Vol: 3, Issue: 12, pp. 65-69.

13. Joao C. Ferreira, Marco Esperança, Year: 2025, "Enhancing Sustainable Last-Mile Delivery: The Impact of Electric Vehicles and AI Optimization on Urban Logistics", World Electric Vehicle Journal, Vol: 16, No: 5, pp. 242.

14. Siow Jat Shern, Md Tanjil Sarker, Mohammed Hussein Saleh Mohammed Haram, Gobbi Ramasamy, Siva Priya Thiagarajah, Fahmid Al Farid, Year: 2024, "Artificial Intelligence Optimization for User Prediction and Efficient Energy Distribution in Electric Vehicle Smart Charging Systems", Energies, Vol: 17, No. 22, pp. 5772.

15. Arti Badhoutiya, R. Srisainath, K. A. Shirbavikar, P. Bhuvaneshwari, Mohammed Al-Farouni, Jitendra Narkhede, Anil Kumar, Year: 2024, "AI-Driven Optimization of Fuel Cell Performance in Electric Vehicles", In E3S Web of Conferences, Vol. 591, pp. 04003, EDP Sciences.

16. Darshan Bhavesh Mehta, Year: 2025, "AI-Enhanced Design and Solar Integration for High-Efficiency Electric Vehicles", International Journal of Research in Aeronautical and Mechanical, Vol: 13, No: 4, pp. 2321-3051.

17. Emily Carter, Year: 2023, "AI-Optimized Energy Storage Systems for HighEfficiency Renewable Energy Integration", International Journal of AI, BigData, Computational and Management Studies, Vol: 4, No: 1, pp. 1-10.

18. Qi Shen, Xin Wen, Siwei Xia, Shuwen Zhou, and Haodong Zhang, Year: 2024, "AI-Based Analysis and Prediction of Synergistic Development Trends in US Photovoltaic and Energy Storage Systems", Annals of Applied Sciences, Vol:5, No: 1.