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***Research paper***

# Performance Analysis of Hybrid Construction Vehicles for Sustainable Development

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**Abstract**

Research teams analyze hybrid construction vehicles for operational characteristics to advance sustainable construction development. Construction hybrid vehicles fulfill practical requirements because diesel equipment in the construction industry generates extensive pollution, necessitating replacement options. The research compares hybrid vehicle performance to conventional diesel vehicles by examining energy efficiency parameters, emission reduction, and operational efficiency attributes. The fusion of electric powertrain technology with internal combustion engines allows hybrid construction vehicles to achieve energy savings and reduced emissions, and fuel usage. Field-based evaluations of real-world hybrid vehicles investigate their operational benefits, which include lower emissions, reduced operational costs, and improved performance. Investigators study the monetary benefits, environmental impacts, and economic sustainability of hybrid cars, focusing on decreased maintenance and fuel expenses. Research shows that hybrid vehicle investments yield immediate cost savings through their extended capabilities, which fulfill sustainability mandates in the construction market. Research has shown that hybrid construction cars will introduce expansion to green building strategies, as they negate all environmental issues in the industry.

***Keywords***: *Hybrid Construction Vehicles; Sustainable Development; Energy Efficiency; Emission Reduction; Electric Powertrain Integration; Environmental and Economic Impact.*

## 1. Introduction

Machines used in the construction industry that rely on fossil fuel as their source of power produce a high amount of energy usage at a carbon footprint (1). Hybrid construction vehicles have become one of the main alternatives to sustainable practices because the market demands an increased number of cars that would combine internal combustion engines (ICE) with electric powertrains [17]. Such vehicles provide opportunities to reduce pollution emissions as well as fuel consumption that meet the industrial environmental goals. These cars open opportunities to reduce the amount of pollution that is emitted as well as the use of fuel, which meets the industrial environmental goals. The studies also provide details on the energy conservation of hybrid building trucks, highlighting their environmental impact and financial benefits compared to traditional diesel trucks [9]. The inclusion of hybrid technology can be applied to the sustainable development of the construction industry by offering better results in terms of operational excellence, optimized performance, emission control, and fuel efficiency [4]. When the critical discussion is concluded, hybrid construction vehicles will be able to establish sustainable building practices due to their amicable operations and promote financial sustainability [3] [2].

## 2. Review of Literature

This paper investigates the performance and emissions of hybrid electric vehicles (HEVs) that use a liquefied petroleum gas (LPG) fuel subsystem to achieve high efficiency and environmental friendliness.
The latest developments have highlighted the importance of hybrid construction automobiles, particularly in novel fields like energy storage systems, regenerative braking, and battery integration. The invention of hybrid construction vehicles has been keen on the integration of the best battery systems, which highly influence the working performance at the construction sites. Moreover, regenerative braking is also stated to cause the consumption of fuel to be more efficient, in addition to aiding in minimizing emissions. These technologies are not only good in enhancing fuel efficiency but also help in reducing CO2 emissions in construction activities, and that is good for the objectives of sustainable development.
The study investigates the functioning of the hybrid system, and it is applied to evaluate the consumption of fuel, power, and the production of airborne contaminants under various driving conditions [13]. When hybrid technology is used with LPG, the results are supposedly

reduced emissions of CO2 and NOx and retained vehicle functions [15]. The storage of LPG systems should also be enhanced further, and the current hybrid powertrain needs to be validated, along with strategies to minimize cold-start emissions. These studies have shown that a parking system using alternative fuel LPG can substitute traditional gas, which will allow HEVs to build cleaner and more efficient transport technology systems.

Valencia-Díaz, Toro, and Hincapié [5] develop an original planning structure to optimize EWC nexus operations for hybrid AC/DC microgrids, which prioritizes sustainable development in distant communities. The proposed research unifies power generation processes and water management together with carbon emission-lowering strategies to optimize resource utilization while decreasing environmental footprint, namely in microgrids. Off-grid and underserved societies receive targeted benefits through this framework, which combines optimization algorithms to distribute energy equitably, manage water supplies, and cut carbon footprints. The hybrid microgrid system shows promise, though it faces challenges from its expensive setup costs, intricate component coordination requirements, and insufficient regulatory standards for expansion potential. Researchers have developed a framework to achieve sustainability objectives in distant territories through comprehensive resource management.

Sithambaram et al. [11] research tests a PV system that integrates with EV charging stations but utilizes a hybrid energy control system to maximize performance with grid connectivity. Browser researchers focus on solar energy systems for electric vehicle charging facilities to increase EV growth by lowering customers' energy costs while reducing their grid-dependent electricity needs [10]. The hybrid system combines predictive algorithms with real-time data analysis to efficiently control power flows, resulting in optimized solar energy utilization while safeguarding power grid stability [8]. EV consumers benefit the most from reduced carbon pollution, enhanced power reliability, and more affordable costs. The analysis acknowledges intermittent solar power patterns yet cautions about advanced battery technologies and significant capital costs to initiate the system. The experimental findings create sustainable advances for future energy systems because they demonstrate that renewable integration within EV charging networks works effectively.

Zhang et al. [7] The paper examines how to merge the heat pumps and electric motor waste heat recovery equipment in electric vehicles to offer the highest possible thermal efficiency and energy savings, which is the approach to multi-objective optimization [16]. The proposed plan successfully incorporates the waste heat recovery systems and heat pumps to achieve thermal regulation and the best energy usage with greater safety of travel. The processes of optimization are influenced by several parameters of systems, and they include energy effectiveness and good operation, and environmental concern combined. When the research shows that the amount of energy consumed in EVs decreases, improved thermal management is achieved. There are accurate management algorithms in the introduction of these systems, which require system complication and initial high costs. Bagdadee et al. [12] This journal article is an extensive report on the power generation systems where both the cow dung biogas and solar thermal and kinetic energy are used to produce sustainable power. Through investigative analysis, the interaction between renewable sources of energy is explored to develop a diversified and reliable electricity generation system [14]. The Cow dung biogas waste-to-energy compatibility with the solar thermal heat capture creates the potential of mechanical power using the kinetic energy systems and provides sustainable energy solutions with a minimum ecological footprint. Hybrid renewable energy systems are advantageous in three aspects in terms of efficient management of resources with reduced carbon at lower levels, which are regionally localized in rural areas that have no centralized grid power systems [6]. System barriers have been identified as the high initial setup costs and the complicated integration requirements as well and the necessity to rely on the resources available locally. This study demonstrates the advantageous capability of hybrid solutions to implement sustainable decentralized power systems.

## 3. Methodology

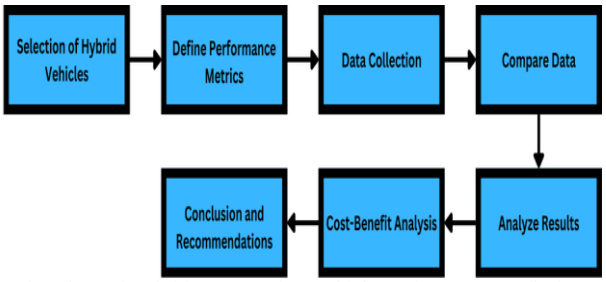


**Fig. 1:** Flowchart of Hybrid Construction Vehicle Performance Analysis Process.

Figure 1 below shows a flowchart that shows how the performance of hybrid vehicles can be analyzed. It illustrates the chronological process of the research, beginning with the choice of hybrid construction vehicles, then data will be obtained as they carry out their business activities, and the final stage would be the performance analysis of the cars in terms of fuel consumption, emissions, and economic efficiency. This is one of the figures that allows the readers to comprehend the research methodology in a clear and organized way.

### 3.1. Selection of hybrid vehicles

The research team analyzed multiple hybrid construction vehicles across a broad spectrum to evaluate their practical performance in building projects.

In this study, three types of hybrid construction vehicles were utilized, and these comprised hybrid excavators, hybrid wheel loaders, and hybrid dump trucks. The sample size of 4 vehicles of each category was used in testing 12 cars at the different construction sites. The performance data was collected within the six months; a representative sample of the working conditions had to be guaranteed.

A mix of hybrid excavators, along with wheel loaders and dump trucks, became the research area since these machines represent three major categories of construction machines that are in use in the industry. The cars were selected based on the industry usage statistics and records on the use of the cars in the project that could be utilized in the study. The hybrid cars in question were evaluated in terms of their three main capabilities, such as increased efficiency due to the use of fuel and reduced exhaust emissions, with efficient construction capabilities due to the electric and combustion engine power mix.

### 3.2. Performance metrics

The study used four key performance measures in the evaluation of hybrid cars: That test has considered fuel consumption the emissions the maintenance cost, and operational effectiveness measures. Fuel consumption performance measurement entails the monitoring of the consumption of fuel among vehicles in some operational periods. The appraisal was calculated on the hourly carbon dioxide emissions. The operating cost was comprised of fuel costs, maintenance costs, and parts replacement costs. Time used and electrical power consumption were the parameters according to which the operational efficiency was measured. The presented assessment processes give an extensive picture of the performance of hybrid vehicles regarding operations and the environment.

### 3.3. Data collection

The researchers used direct observation of the hybrid vehicles in the process of their day-to-day construction. Each row was equipped with a state-of-the-art tracking mechanism, which measured the quantity of fuel burnt in monitoring pollutants. Several data collection rounds were done at various times of the day to measure cars in various working situations during various workload job tasks and environmental conditions. This ground-based method of monitoring was a great source of detailed information on how the hybrid cars have been utilized in the construction settings, with considerable comparison to the traditional cars.
The statistical procedure that was applied in the data analysis incorporated the descriptive statistics to explain the fuel consumption, the emissions, and the efficiency of the operation. In addition, regression analysis was performed to determine the correlation between the nature of the vehicle being used and the performance outcomes, which comprised the fuel efficiency and the emission reduction.

### 3.4. Comparison to conventional vehicles

The statistical operation that was used in the data analysis included descriptive statistics to describe fuel consumption, emissions, and the operation efficiency. In addition, regression analysis was performed to determine the correlation between the nature of the vehicle being used and the performance outcomes, which comprised the fuel efficiency and the emission reduction. Traditional diesel automobiles operated as an industry reference point to compare hybrid technology benefits in an evaluation. The study evaluates performance baselines through measurements of fuel use and pollution generation to establish operational budgetary contributions. The analysis of hybrid and conventional truck performance under corresponding measurement criteria established quantifiable benefits of hybrid transportation during construction operations.

## 4. Result

### 4.1. Fuel efficiency

Standard diesel-powered construction vehicles fell behind hybrid models during fuel economy tests, where the savings amounted to 15 to 30 percent. According to test data, the hybrid excavator achieved the highest fuel efficiency increase of 30% because of its regenerative braking system and electric powertrain technology for operating in idle and low-load scenarios. Multiple vehicle types, including hybrid wheel loaders and dump trucks, showed considerable improvements in fuel efficiency. The performance advantages generate substantial long-term fuel cost reductions that boost sustainability across building development initiatives.

**Table 1:** Fuel Consumption Rates and Percentage Improvements for Hybrid and Diesel Construction Vehicles, Demonstrating Significant Efficiency Gains

| Vehicle Type | Fuel Consumption (liters/hour) | Improvement (%) |
|---|---|---|
| Hybrid Excavator | 15.5 | 30% |
| Hybrid Wheel Loader | 12.8 | 20% |
| Hybrid Dump Truck | 18.0 | 15% |
| Diesel Excavator | 22.0 | 0% |

### 4.2. Emission reductions

Hybrid vehiclesachieved notable developments as a source for decreased emissions. The carbon dioxide emission levels decreased by twenty percent for hybrid dump trucks and by twenty-five percent for hybrid wheel loaders, facing competition versus conventional diesel-based models. Two key causes of total emission reduction stem from the electric motor operating efficiently at low loads and implementing regenerative braking that alternates between electric and conventional-powered driving modes. The reduction of $CO_2$ emissions both satisfies environmental regulations and promotes sustainable building practices.

**Table 2:** $CO_2$ Emissions Comparison for Hybrid and Diesel Vehicles, Highlighting Reductions Achieved with Hybrid Technology

| Vehicle Type | $CO_2$ Emissions ($gCO_2/kWh$) | Reduction (%) |
|---|---|---|
| Hybrid Wheel Loader | 180 | 25% |
| Hybrid Dump Truck | 220 | 20% |
| Diesel Wheel Loader | 240 | 0% |
| Diesel Dump Truck | 270 | 0% |

### 4.3. Operating efficiency

Hybrid vehicles defeated diesel vehicles by completing tasks 10-20% quicker than their counterparts. The capability of hybrid cars to use electric power at low load situations improves their operating speed during idling periods or light duties. The hybrid excavator completed work assignments 15% more quickly than its diesel counterpart, and hybrid dump trucks finished their tasks at 10% enhanced speed. The more efficient system allows projects to finish earlier while boosting overall site performance.

**Table 3:** Task Completion Times for Hybrid and Diesel Construction Vehicles, Showcasing Improvements in Operational Efficiency

| Vehicle Type | Task Completion Time (hours) | Improvement (%) |
|---|---|---|
| Hybrid Excavator | 8.5 | 15% |
| Hybrid Dump Truck | 12.0 | 10% |
| Diesel Excavator | 10.0 | 0% |
| Diesel Dump Truck | 13.0 | 0% |

### 4.4. Cost analysis

The premium cost of acquiring hybrid vehicles translates into reduced operational expenses through improved fuel efficiency and maintenance savings that add up to a 10 to 15 % discount in five years. The hybrid system reduces dependence on oil-based power by using electricity for vehicle functions and leads to less component deterioration, thereby lowering overall maintenance expenses. The efficiency-boosted fuel consumption provides better price savings than the higher purchase rates. Hybrid vehicles maintain the long-term financial advantage for construction enterprises that want to reduce expenses through better sustainability efforts.

**Table 4:** Cost Analysis of Hybrid and Diesel Vehicles, Including Initial Costs, Fuel and Maintenance Savings, and Total Savings Over 5 Years

| Vehicle Type | Initial Cost (USD) | Annual Fuel Savings (USD) | Maintenance Savings (USD) | Total Savings (5 years) |
|---|---|---|---|---|
| Hybrid Excavator | 250,000 | 8,000 | 5,000 | 65,000 |
| Hybrid Dump Truck | 270,000 | 7,500 | 4,500 | 60,000 |

## 5. Discussion

The performance study reveals hybrid construction vehicles generate multiple value points through better fuel economy, paired with lower emissions and reduced total costs. The expensive starting cost of hybrid cars remains a significant obstacle that inhibits widespread adoption, especially in price-sensitive developing construction markets. Through long-term fuel cost savings combined with maintenance expense reductions and environmental advantages, hybrid automobiles present an appealing option for sustainable construction. Performance indicators for hybrid vehicles remain sensitive to their ecological working conditions. While construction locations featuring alternating work sites enable optimized electric powertrain delivery system performance, the system falls short of traditional car performance during heavy work hours. The broader acceptance of hybrid cars is limited by the creation of a specification, corresponding to certain construction needs of buildings. Introduction of solar-powered charging infrastructure to power hybrid automobiles, coupled with renewable energy systems, reduces emissions besides enhances the lifespan of hybrid cars.

To counter the above-mentioned barrier in the form of high initial costs of vehicles constructed in hybrid form, certain cost-reduction techniques could be referred to. Some of these measures include the development of cost-effective battery technologies that can render the entire vehicle a significantly cheaper alternative. Also, the large-scale production could contribute to the reduction of production costs due to economies of scale. Government subsidies, tax breaks, and grants on sustainable technology are also instrumental in ensuring that the hybrid vehicles are more affordable to construction companies, especially those in the developing markets.

Future research should focus on streamlining the hybrid vehicle technologies in terms of the construction industry, to refine the energy storage facilities and the efficiency of the regenerative braking facilities. The potential follow-up to the efficiency enhancement of the processes and the money saving would be the discovery of how construction vehicles involving hybrids can be optimized using the assistance of innovative technologies in construction, which is the IoT that could monitor the performance of the vehicles in real-time and perform predictive maintenance. Additionally, the research that can be conducted on the development of the solar-powered charging stations that would be specialized to be constructed at the construction sites could help lessen the use of fossil energy, and the cost of operating the stations would also be lowered.

## 6. Conclusion

The hybrid nature of construction vehicles ensures they can transform the industrial processes by introducing innovations that will help it overcome the challenges of fuel efficiency, which will go hand in hand with the reduction of pollution and improvements in the operation system. The hybrid technology that involves the use of electric power systems together with internal combustion engines would be more environmentally friendly compared to the latter, which uses diesel engine technology and enhances the efficiency of resource utilization. Hybrid vehicles will also be embraced by Sustainable construction companies because their high starting price will be reflected in high performance in terms of fuel economy and lower cost of service provision, as well as improved performance during the long life of the vehicle. The solar-powered charging stations will help the construction industry cut the cost of hybrid vehicles to the environment. The expensive nature of start-up costs and the requirement to have infrastructural facilities are among the reasons why these technologies cannot be applied on a large scale. Scientists must focus on hybrid vehicle advancement to lower manufacturing prices while developing essential system frameworks needed for construction companies to adopt these vehicles on a broad scale.

## References


[1] Lv, K., Wang, Q., Shi, X., Huang, L., & Liu, Y. (2025). Multi-Scale Mapping of Energy Consumption Carbon Emission Spatiotemporal Characteristics: A Case Study of the Yangtze River Delta Region. *Land*, *14*(1), 95. https://doi.org/10.3390/land14010095.

[2] Kim, M., Go, Y., Choi, S., Kim, N., Yoon, C., & Park, W. (2023). A Study on the Analysis of Law Violation Data for the Creation of Autonomous Vehicle Traffic Flow Evaluation Indicators. Journal of Internet Services and Information Security, 13(4), 185-198. https://doi.org/10.58346/JISIS.2023.I4.013.

[3] Olanrewaju, A. (2025). Application of structural equation modeling (SEM) to evaluate reworks in sustainable buildings—*Frontiers in Engineering and Built Environment.* https://doi.org/10.1108/FEBE-07-2024-0033.

[4] Afnaan, K., Pati, P. B., Singh, T., & Prakash, K. N. B. (2024). Comparative Analysis for Feature Extraction and Prediction of CKD Using Machine Learning. *Journal of Wireless Mobile Networks, Ubiquitous Computing, and Dependable Applications, 15*(2), 202-225. https://doi.org/10.58346/JOWUA.2024.I2.014.

[5] Jeong, J. W., Woo, S., Koo, B., & Lee, K. (2025). Analysis of hybrid electric vehicle performance and emission applied to the LPG fuel system. *Fuel, 380,* 133225. https://doi.org/10.1016/j.fuel.2024.133225.

[6] Bradley, T. H., & Frank, A. A. (2009). Design, demonstrations and sustainability impact assessments for plug-in hybrid electric vehicles. *Renewable and Sustainable Energy Reviews*, *13*(1), 115-128. https://doi.org/10.1016/j.rser.2007.05.003.

[7] Sithambaram, M., Rajesh, P., Shajin, F. H., & Rajeswari, I. R. (2025). Grid-connected photovoltaic system-powered electric vehicle charging station for energy management using a hybrid method. *Journal of Energy Storage, 108,* 114828. https://doi.org/10.1016/j.est.2024.114828.

[8] Ekambaram, Y., & Tripathi, M. (2025). Adopting hybrid wireless network architectures to support autonomous maritime vehicle operations. Journal of Wireless Mobile Networks, Ubiquitous Computing, and Dependable Applications, 16(2), 95–104. https://doi.org/10.58346/JOWUA.2025.I2.006.

[9] Uutoni, T. K., Musti, K. S., & Amushembe, H. (2025). Electric Buses for Urban Transport Systems. In Optimized Energy Management Strategies for Electric Vehicles (pp. 1-34). *IGI Global Scientific Publishing.* https://doi.org/10.4018/979-8-3693-6844-2.ch001.

[10] Reddy, R. T., & Chawla, N. (2021). An Energy-Effective Model for Electric Vehicle Charging Station Placement Selection. International Academic Journal of Science and Engineering, 8(2), 31–35.

[11] Valencia-Díaz, A., Toro, E. M., & Hincapié, R. A. (2025). Optimal planning and management of the energy-water–carbon nexus in hybrid AC/DC microgrids for sustainable development of remote communities. *Applied Energy, 377,* 124517. https://doi.org/10.1016/j.apenergy.2024.124517.

[12] Zhang, Y., Zhao, D., Wu, L., He, L., Huang, J., & Zhao, Y. (2025). Multi-objective optimization under the mixed utilization strategy of heat pump and electric drive waste heat of electric vehicles. *Applied Thermal Engineering, 259,* 124900. https://doi.org/10.1016/j.applthermaleng.2024.124900.

[13] Mamun, K. A., Islam, F. R., Haque, R., Chand, A. A., Prasad, K. A., Goundar, K. K., ... & Maharaj, S. (2022). Systematic modeling and analysis of on-board vehicle integrated novel hybrid renewable energy system with storage for electric vehicles. *Sustainability*, *14*(5), 2538. https://doi.org/10.3390/su14052538.

[14] Klein, D. (2025). Design and Analysis of a Lightweight HighTorque Gearbox for Electric Vehicles. Association Journal of Interdisciplinary Technics in Engineering Mechanics, 3(1), 15-19.

[15] Rao, Y. (2020). New energy vehicles and sustainability of energy development: Construction and application of the Multi-Level Perspective framework in China. *Sustainable Computing: Informatics and Systems*, *27*, 100396. https://doi.org/10.1016/j.suscom.2020.100396.

[16] Saju, C., Michael, P. A., & Jarin, T. (2022). Modeling and control of a hybrid electric vehicle to optimize system performance for fuel efficiency. *Sustainable Energy Technologies and Assessments*, *52*, 102087. https://doi.org/10.1016/j.seta.2022.102087.

[17] Kommula, B. N., & Kota, V. R. (2015, December). Performance evaluation of hybrid fuzzy PI speed controller for brushless DC motor for electric vehicle application. In *2015 Conference on power, control, communication and computational technologies for sustainable growth (PCCCTSG)* (pp. 266-270). IEEE. https://doi.org/10.1109/PCCCTSG.2015.7503912.

[18] Arvinth, N. (2025). Effect of Pranayama on respiratory efficiency and stress levels in adolescent athletes. Journal of Yoga, Sports, and Health Sciences, 1(1), 1–8.

[19] Patel, P., & Dusi, P. (2025). IoT-based water quality management system for sustainable urban water networks. Journal of Smart Infrastructure and Environmental Sustainability, 2(1), 11–20.

[20] Barhoumia, E. M., & Khan, Z. (2025). Neurocognitive mechanisms of adaptive decision-making: An fMRI-based investigation of prefrontal cortex dynamics in uncertain environments. Advances in Cognitive and Neural Studies, 1(1), 20–27.

[21] Rahman, F., & Prabhakar, C. P. (2025). Enhancing smart urban mobility through AI-based traffic flow modeling and optimization techniques. Bridge: Journal of Multidisciplinary Explorations, 1(1), 31–42.

[22] Surendar, A. (2025). Wearable sensor analysis of biomechanics in Yoga Asanas for posture correction. *Journal of Yoga, Sports, and Health Sciences*, 1-7.

[23] Mishra, N., & Nandkeolyar, R. (2023). Wavelet-Based Time–Frequency Analysis of Nonlinear Acoustic Wave Propagation in Heterogeneous Media. *Advanced Computational Acoustics Engineering*, *1*(1), 1-8.

[24] Nymana, F. G., & Usun, S. (2023). Enhancing Rural Livelihoods through ICT-Enabled Digital Extension Services in Agriculture. *National Journal of Smart Agriculture and Rural Innovation*, *1*(1), 57-64.

[25] Dusi, P., & Rahman, F. (2025). Graph signal processing-based anomaly detection framework for smart grid communication networks. Progress in Electronics and Communication Engineering, 3(1), 54–58.

[26] Gichoya, D., & Mzeh, H. K. (2025). An energy-efficient FPGA-based architecture for real-time edge AI applications. SCCTS Transactions on Reconfigurable Computing, 3(1), 1–10.

[27] Pamije, L. K., & Havalam, N. K. (2025). Zero-shot learning for remote sensing image segmentation using cross-domain transfer and self-training. National Journal of Signal and Image Processing, 1(2), 52–59.

[28] Tsai, X., & Jing, L. (2025). Hardware-based security for embedded systems: Its protection against modern threats. Journal of Integrated VLSI, Embedded and Computing Technologies, 2(2), 9–17.

[29] Tamrakar, G., & Smith, O. J. M. (2025). OTA-validated SDR-based mmWave RF transceiver architecture for 5G wireless communication systems. National Journal of RF Circuits and Wireless Systems, 3(2), 57–64.

[30] Chandrakumar, R., & Soria, F. (2025). Lightweight deep neural networks for real-time speech enhancement on edge devices. National Journal of Speech and Audio Processing, 1(3), 1–8.

[31] Ramchurn, R. (2025). Advancing autonomous vehicle technology: Embedded systems prototyping and validation. SCCTS Journal of Embedded Systems Design and Applications, 2(2), 56–64.

[32] Hugh, Q., & Luedke, R. G. (2025). High-voltage SiC-based DC–DC converters for green hydrogen production and storage systems. National Journal of Electrical Machines & Power Conversion, 1(4), 16–23.