iJRASET
International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 14 **Issue:** IV **Month of publication:** April 2026

DOI: https://doi.org/10.22214/ijraset.2026.80064

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 14 Issue IV Apr 2026- Available at www.ijraset.com

Design and Analysis of Hydrogen Fuel Cell Powered Electric Two-wheeler: A Comprehensive Review

Ms. Alisha J. Shaikh[1], Prof. Vishal Pimpalkar[2]
[1]*PG Student, Department of Electrical Engineering, Ballarpur Institute of Technology (BIT), Ballarpur, Maharashtra, India,*
[2]*Head of Department, Electrical Engineering, Ballarpur Institute of Technology (BIT), Ballarpur, Maharashtra, India*

Abstract: ***The implementation of hydrogen fuel cell technology provides an effective method for creating sustainable transportation because it produces no emissions while delivering high energy efficiency and enabling quick refueling. Fuel cell electric vehicles generate electricity through an electrochemical reaction between hydrogen and oxygen, which produces only water and heat as by-products. This makes them environmentally friendly alternatives to fossil-fuel-based vehicles. The recent studies demonstrate that proton exchange membrane fuel cells (PEMFCs) provide excellent performance for automotive applications because they offer high power density and efficiency. The use of hybrid fuel cell–battery systems has become common to achieve better performance and extended range and enhanced energy management capabilities. Research shows that fuel cell hybrid two-wheelers provide substantial improvements in driving range and operational efficiency compared to battery-only vehicles. The hydrogen storage problem and the infrastructure availability issue and the system cost problem still prevent widespread commercial implementation of hydrogen technology. Hydrogen fuel cell technology demonstrates strong potential to create future clean mobility systems particularly through its connection with renewable hydrogen production and advanced energy management implementation.***

Keywords: ***Hydrogen Fuel Cell, Fuel Cell Electric Vehicle (FCEV), Hybrid Fuel Cell Battery System, Sustainable Transportation, Proton Exchange Membrane Fuel Cell (PEMFC) etc.***

I. INTRODUCTION

The world experiences higher fuel consumption and air pollution and greenhouse gas emissions because of the rising need for transportation which simultaneous urban expansion. Conventional internal combustion engine vehicles require fossil fuels for operation which leads to severe damage to the environment and drives climate change. The world now needs to develop transportation systems that use sustainable eco-friendly technologies as their primary solution. Hydrogen fuel cell vehicles have developed into a valuable transportation option because their operation produces zero emissions and their system achieves maximum performance efficiency [1].electrical power production in fuel cell electric vehicles occurs through an electrochemical reaction that combines hydrogen with oxygen which results in water vapor and heat as the only waste products. The design of fuel cells allows them to produce power continuously through hydrogen supply which makes them ideal for use in applications that require long-distance operation [6]. Hydrogen fuel cell vehicles offer multiple benefits including their quick refueling capability and extended driving range and their ability to perform consistently in various weather conditions [7].

Proton exchange membrane fuel cells (PEMFCs) because of their efficient performance and compact design and their ability to generate high power output have become the most common fuel cell type used in transportation systems. The design characteristics of PEM fuel cells make them ideal for use in both automotive vehicles and two-wheeled motorized vehicles. The research community has studied fuel cell technology extensively for use in passenger cars and buses and heavy-duty vehicles, but there exists a research gap regarding its application in lightweight vehicles such as scooters and motorcycles [3].

Two-wheelers play a major role in personal transportation, especially in developing countries. The use of petrol-powered two-wheelers leads to major air pollution problems in urban environments. The use of battery electric two-wheelers results in cleaner emissions, but their performance gets restricted because of three major problems, which include limited driving range and long charging time and battery degradation. Hybrid fuel cell–battery systems have been proposed as an effective solution to overcome these limitations. In such systems, the fuel cell functions as a range extender while the battery supplies power for both acceleration and hill climbing needs [3].

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Studies demonstrate that hybrid fuel cell scooters provide better range and longer operational time than scooters powered solely by battery systems. Experimental results demonstrate that fuel cell integration can increase driving range by a considerable margin while improving overall energy efficiency 4. The studies which use MATLAB/Simulink simulations demonstrated that fuel cells and batteries shared power effectively during dynamic load conditions 8. Hydrogen storage represents a vital element that determines how well fuel cell vehicles function. Researchers develop advanced storage technologies which include compressed gas tanks and cryogenic storage and metal hydride storage because hydrogen exists as a low density gas 5. Hydrogen storage systems require ongoing research efforts to achieve compact designs which meet the needs of small vehicles.

Hydrogen fuel cell vehicles face deployment problems because their benefits are countered by multiple existing difficulties. The commercialization process faces three main obstacles which include insufficient hydrogen refueling stations and expensive system implementation and safety risks from hydrogen storage. The current limitations of research and technology development will experience improvements through future research efforts and technological progress [5].

Hydrogen fuel cell technology provides an effective path which enables development of transportation systems that use sustainable energy sources. Continuous improvements in fuel cell materials and hydrogen production methods and storage technologies will enable fuel cell vehicles to assist in attaining worldwide emission reduction goals. The use of hydrogen fuel cells in two-wheeled vehicles establishes a vital research field which supports environmentally friendly urban transportation systems through reduced fossil fuel usage.

II. PROBLEM IDENTIFICATION

The transportation sector is one of the major contributors to global air pollution and greenhouse gas emissions because it relies heavily on fossil fuel-powered vehicles for its operations [1]. The operation of traditional two-wheelers which use petrol engines results in dangerous emissions that create health threats and environmental damage within urban environments [2]. Battery electric two-wheelers offer cleaner transportation options but they face three main obstacles which include driving range restrictions and slow charging times and battery performance decline [3]. The two-wheelers face two main obstacles which hinder user acceptance and prevent their widespread adoption.

Hydrogen fuel cell technology provides an emissions-free solution that delivers outstanding energy storage capacity and quick refueling capabilities [4]. The use of fuel cells in lightweight vehicles which include two-wheelers remains restricted because of three main factors which are high system expenses and difficulties with hydrogen storage and absence of refueling stations [5]. The field lacks extensive studies that focus on optimizing hybrid fuel cell-battery systems which specifically cater to two-wheeler applications [6]. The development of effective hybrid powertrain models together with their control systems needs to happen because this process will enhance vehicle performance and operational range and complete system efficiency [7].

III. LITERATURE SURVEY

A. Literature Review

A. Kumar et. al. (2023), The study provides an extensive assessment of two-wheelers powered by hydrogen fuel cells which investigates their system design their operational capabilities and their ecological advantages. The study compares battery-electric and fuel cell–battery hybrid configurations, concluding that hybrid architectures are more suitable for two-wheelers due to improved range and efficiency. The authors demonstrate that fuel cells used as range extensions decrease both battery stress levels and battery deterioration. The article discusses three main obstacles which include hydrogen storage challenges and high costs and insufficient infrastructure. The review emphasizes that hydrogen-powered two-wheelers can significantly reduce urban emissions and are promising alternatives to conventional electric scooters when optimized power management strategies are employed.

R. Mohan et. al. (2024), The study examines cutting-edge developments in proton exchange membrane fuel cell (PEMFC) systems which researchers have developed for use in light electric vehicles. The research demonstrates three advancements that enable power generation through PEMFC systems which researchers have developed for small vehicles like scooters and bicycles. The authors study how power output changes with different operating conditions while they evaluate system efficiency. The research demonstrates that contemporary PEM fuel cell systems provide consistent electricity output which meets requirements for urban transportation systems. The study demonstrates that material developments together with decreasing expenses will drive the implementation of PEM fuel cells in light transportation systems.

J. Rivera et. al. (2023), The research examines fuel cell applications for extending electric motorcycle operating range. The research investigates hybrid powertrain systems which operate with constant fuel cell power and battery power during peak demand periods. The study demonstrates that electric motorcycles with integrated fuel cells achieve greater driving range than battery-powered

motorcycles. The authors present two findings which show that reduced battery cycling results in extended battery lifespan and increased battery reliability. The research demonstrates that fuel cell range extenders enhance system performance while serving as an optimal solution for urban and suburban environments which experience regular stop-and-go driving.

T. Smith et. al. (2024), The study investigates how hybrid power systems that combine fuel cells and battery systems function in urban mobility use cases. The research focuses on urban stop-and-go traffic situations to measure how energy transfers between the fuel cell system and battery system. The results show that hybrid systems create a system that can handle both short power needs and continuous energy use which results in better energy savings and longer operational time. The authors emphasize that effective power management methods are essential for achieving optimal system operation. The paper concludes that hybrid FC–battery architectures are more practical than standalone fuel cell systems for compact urban vehicles.

P. Sharma et. al. (2022), The research develops a simulation framework which uses MATLAB and Simulink to model hydrogen fuel cell powertrains for two-wheeler vehicles. The research combines fuel cell models with battery behavior and DC/DC converter systems and electric motor operation. The simulation results demonstrate precise predictions of fuel cell efficiency and hydrogen usage and battery state of charge changes across various driving conditions. The authors show that simulation serves as a vital tool during the initial design phase because it helps to decrease both development expenses and project duration. The research demonstrates that MATLAB/Simulink functions as a dependable system for testing hybrid fuel cell and battery systems before actual prototype development.

R. Yamada et. al. (2023), The study examines hydrogen storage methods that work for lightweight vehicles. The study evaluates three storage systems which include compressed gas tanks metal hydrides and advanced composite materials. The authors show that carbon-fiber-reinforced composite tanks stand as the optimal solution which achieves weight reduction along with safety protection and storage capacity for two-wheeled vehicles. The research examines safety features which include protection against leaks and ability to withstand crashes. The research demonstrates that progress in lightweight composite materials development is crucial for hydrogen storage systems to be used in small vehicles such as bicycles and scooters.

F. Ahmed et. al. (2024), The assessment focuses on fuel cell operation under changing load conditions which are common in vehicle usage. The research shows that fuel cells respond to power demands more slowly than batteries do which makes them unsuitable for applications that require immediate energy output. The authors recommend hybridization with batteries or ultracapacitors to buffer load variations. The research shows that battery usage with fuel cells leads to increased system stability and operational efficiency according to both experimental data and simulation results. The researchers found that dynamic load management serves as an essential requirement for effective fuel cell implementation in mobile systems.

K. Brown et. al. (2023), The researchers examine multiple standardized driving patterns to determine which ones are appropriate for studying the electrification of two-wheeler vehicles. The authors compare WMTC, NEDC, and WLTC cycles, concluding that WMTC best represents real-world urban riding behavior. The researchers demonstrate through their work that selecting the correct driving cycle will determine three main outcomes which include energy consumption measurement and fuel cell design and control system assessment. The study demonstrates that selecting the wrong driving cycle will result in incorrect performance assessment. The researchers recommend using WMTC for simulation-based research about electric and fuel cell-powered two-wheeled vehicles.

L. Choi et. al. (2022), The study investigates current advances in BLDC motor control methods which are used in fuel cell powered vehicles. The study demonstrates how vector control together with advanced PWM techniques can be used to enhance motor performance by achieving greater efficiency and reduced torque ripple. The authors show that optimized DC/AC converters can enhance power utilization from fuel cell battery systems. The new control methods deliver two benefits which include reduced energy waste and better vehicle control. The paper concludes that efficient motor control is essential for maximizing the benefits of fuel cell powertrains in lightweight electric vehicles.

D. Wilson et. al. (2024), The study determines hydrogen-based mobility solutions through their potential for sustainable development. The research studies emissions throughout the entire lifecycle of the system together with renewable hydrogen production and its energy integration process. The research demonstrates that hydrogen-powered transportation systems achieve lower greenhouse gas emissions when renewable energy sources produce hydrogen fuel. The authors demonstrate that their system provides benefits through fast refueling times and its ability to store energy. The research demonstrates that hydrogen-powered vehicles which include two-wheelers serve as essential components for cities to reach their sustainable transportation targets throughout their urban areas.

B. Literature Summary

Recent research shows that hydrogen fuel cell technology exists as an environmentally friendly and efficient solution which will power upcoming transportation systems. According to studies, PEM fuel cells deliver high power density together with quick response times which meet the requirements for vehicle applications. For lightweight vehicles, hybrid fuel cell–battery systems receive widespread recommendation because they enhance driving range and improve energy efficiency. The evaluation of fuel cell performance together with energy management strategies requires simulation tools which include MATLAB/Simulink.

Research demonstrates that fuel cell range extenders enable electric vehicles to achieve greater driving distances than vehicles which operate solely on battery power. Studies show that drive cycle analysis requires WMTC because it provides better assessments of two-wheeler performance in real-world conditions. The development of hydrogen storage technologies now allows small vehicles to use safer and lighter storage systems. The available literature demonstrates that hydrogen fuel cell powered two-wheelers exist as a viable option for sustainable urban transportation.

C. *Research Gap*

1) Research on hydrogen fuel cell two-wheelers remains limited because most studies target passenger cars and heavy vehicles as their research subjects according to [2].
2) The existing research lacks complete MATLAB/Simulink simulation models which need to integrate fuel cell systems battery systems motor systems and control systems for two-wheeler applications according to [4].
3) The existing research lacks sufficient studies which investigate optimal fuel cell sizing methods for lightweight vehicle applications under actual driving conditions according to [5].
4) The existing research provides insufficient information about advanced SOC-based fuel cell control strategies which optimize energy management systems according to [3].
5) The existing research includes few studies which compare performance across multiple standard drive cycles according to [6].
6) Current research fails to completely solve the hydrogen storage integration issues that affect small vehicles according to [7].
7) Research on system design for practical system implementation and commercial product development remains limited according to [1].

IV. RESEARCH METHODOLOGY

A. *Criteria for selecting this study:*

The research project examines the need for clean and sustainable transportation technologies because of their rising demand. The increasing pollution of the environment together with the exhaustion of fossil fuels creates a requirement for new energy sources that can power transportation systems.

The hydrogen fuel cell technology serves as a viable solution because it produces no emissions while generating energy through its efficient systems. The daily transportation needs of urban and semi-urban areas make two-wheelers suitable for using clean energy solutions. The research investigates hybrid fuel cell-battery systems which provide electric vehicles with battery limitations through their extended range and reduced charging duration capabilities.

The availability of MATLAB/Simulink advanced simulation tools allows precise system performance assessment before actual hardware testing occurs. The research supports hydrogen mobility development while contributing to global sustainability goals through renewable energy systems and green transportation programs.

B. *Method of Analysis*

The method of analysis is based on simulation modeling using MATLAB/Simulink to evaluate the performance of the hydrogen fuel cell powered two-wheeler. The system creates its model through the integration of essential components which include hydrogen fuel cell stack and battery pack and DC/DC converter and inverter and BLDC motor. The fuel cell operates as a range extender which provides constant power to the battery system that manages all sudden changes in power requirements. Standard drive cycles such as WMTC are used to analyze vehicle performance under real riding conditions. The system assesses various parameters which include hydrogen consumption and battery state of charge (SOC) and motor power output and system efficiency. The research tests various fuel cell sizes and control strategies to identify the most efficient system setup. The simulation results are analyzed using performance graphs and comparative data to validate system feasibility and energy efficiency under various operating conditions.

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C. Comparison and Analysis

Sr. No.	Literature / Study	System Type	Key Parameters Compared	Performance Outcome
1	Kumar & Patel (2023)	FC–Battery Hybrid Two-Wheeler	Efficiency, Driving Range, Emissions, Energy Density	Hybrid systems showed higher efficiency, longer range, and zero emissions compared to conventional electric scooters.
2	Mohan & Das (2024)	PEM Fuel Cell Vehicle System	Power Density, Durability, Response Time, Efficiency	Improved PEMFC materials increased durability and power density, making them suitable for lightweight vehicle applications.
3	Rivera & Lopez (2023)	FC Range Extender Motorcycle	Battery Life, Range Extension, Power Stability, Energy Consumption	Fuel cell range extender increased vehicle range and reduced battery stress under variable load conditions.
4	Smith & Zhang (2024)	Hybrid FC–Battery Urban Vehicle	Energy Management, Efficiency, Transient Response, Operating Range	Hybrid system improved energy sharing and provided better performance in stop-go urban traffic conditions.
5	Sharma & Singh (2022)	MATLAB Simulated FC Powertrain	SOC Behavior, Hydrogen Consumption, System Efficiency, Power Output	Simulation accurately predicted system behavior and validated hybrid FC-battery feasibility for two-wheelers.
6	Yamada & Ito (2023)	Hydrogen Storage System	Weight, Safety, Storage Capacity, Compactness	Composite hydrogen tanks provided best balance of lightweight design and safety for small vehicles.
7	Ahmed & Reza (2024)	FC Dynamic Load Performance	Load Response, Stability, Efficiency, Power Delay	Battery buffering improved stability and compensated for fuel cell slow transient response.
8	Brown & O'Neil (2023)	Drive Cycle Performance Study	Energy Consumption, Speed Profile, Efficiency, Range Estimation	WMTC drive cycle provided most realistic two-wheeler energy consumption and performance prediction.

D. Evaluation of methodologies used in the reviewed studies

The reviewed studies primarily use simulation-based experimental methods and analytical approaches to study hydrogen fuel cell systems which are designed for transportation applications. Many researchers use advanced simulation tools such as MATLAB/Simulink to model fuel cell–battery hybrid powertrains which enables them to predict system behavior and energy consumption and performance across various driving scenarios. Simulation methods provide businesses with a budget-friendly solution which enables them to assess different design options through testing while they remain without actual physical models. Some studies also use 1D powertrain modeling and drive cycle-based analysis, such as WMTC and WLTC, to replicate real-world vehicle operating conditions.

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The selected studies use experimental methods to test their simulations and assess actual fuel cell systems which operate under changing load conditions. The methods provide useful practical knowledge, but they require significant financial resources and extended periods of time to implement.

The analytical methods study performance equations, energy flow analysis, and control strategy evaluation. The combination of simulation and experimental validation through hybrid methods delivers the most dependable research results. The existing studies do not include extensive testing in actual environments, which demonstrates the necessity for additional research through prototype development and extended assessment of hydrogen fuel cell two-wheelers.

E. Highlighting trends, advancements, and challenges

1) Trends

- Hydrogen fuel cell technology receives increasing attention as a solution for developing clean transportation methods.
- Hybrid fuel cell-battery powertrain systems experience rising acceptance in the market.
- Vehicle system designers utilize simulation software tools which include MATLAB and Simulink for their design work.
- Researchers develop lightweight hydrogen storage systems which target smaller vehicle applications.
- Scientists conduct research on hydrogen-based mobility solutions which they apply to urban transportation systems.

2) Advancements

- Vehicle applications now feature PEM fuel cells with improved efficiency and durability.
- Engineers have created fuel cell stack designs which offer compactness and lightweight features.
- Advanced power electronic converters provide effective energy management solutions through their performance capabilities.
- Engineers have developed hydrogen storage materials which offer improved safety features.
- Better motor control techniques improve the performance of electric vehicles.

3) Challenges

- Hydrogen fuel cell systems require high initial investment costs for their implementation.
- The infrastructure for hydrogen refueling remains limited in its current availability.
- Safety risks exist because of the methods used to store and handle hydrogen.
- Compact two-wheeler vehicle designs face difficulties because of their intricate integration requirements.
- The process needs both real-world performance testing and long-term durability assessment to establish its validity.

V. DISCUSSION

A. Synthesis of findings from literature

1) The literature provides evidence that hydrogen fuel cell technology functions as an effective option for creating zero-emission transportation systems.

2) The most appropriate design for lightweight vehicles and two-wheelers consists of hybrid fuel cell-battery systems.

3) The research shows that fuel cells maintain constant output while batteries handle short-term power needs.

4) The research shows that fuel cells serve as effective range extenders because they significantly enhance driving distance.

5) PEM fuel cells receive widespread adoption because they deliver high efficiency and their small size allows for greater power output.

6) MATLAB/Simulink simulation studies enable accurate prediction of system performance and SOC changes and hydrogen usage.

7) Hydrogen storage developments through composite tanks enable their use in compact vehicle systems.

8) Fuel cell vehicle performance assessment requires drive cycle-based testing to achieve accurate results.

9) The main obstacles to progress include expensive costs and the lack of hydrogen infrastructure and storage systems that lack safety features.

10) The research demonstrates that hydrogen fuel cell two-wheelers represent a sustainable mobility solution which shows potential for future development.

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B. Methodology for future research directions

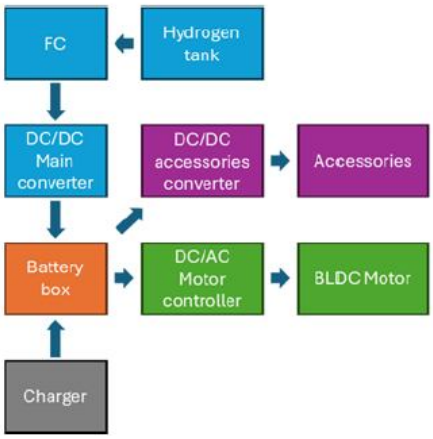


Figure 1. Block Diagram of system

1) The two-wheeler uses a high-pressure lightweight hydrogen storage system, which consists of a storage tank.
2) The proton exchange membrane (PEM) fuel cell receives hydrogen, which combines with oxygen from air to produce electrochemical reactions during its operational phase.
3) As a result of the reaction, the system produces direct current (DC) electricity together with heat and water, which serves as the only waste material.
4) The DC output from the fuel cell uses a DC/DC converter to control its voltage level according to system requirements.
5) The fuel cell operates as a range extender, which provides power at a constant output level.
6) The rechargeable battery pack stores energy and delivers power for instant use, which supports acceleration, climbing, and load changes.
7) The system continuously tracks battery state of charge (SOC), which triggers fuel cell activation when SOC reaches the established minimum level.
8) Battery power enters a DC/AC inverter, which uses the electricity to operate the BLDC motor.
9) The BLDC motor transforms electrical power into mechanical power, which enables the two-wheeler to move in a smooth and efficient manner.

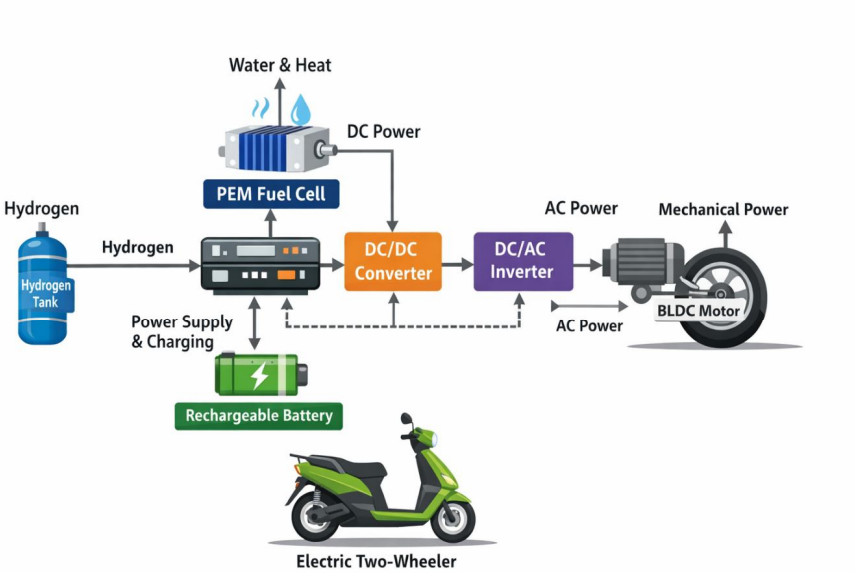


Figure 2. Flow Diagram of system

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10) The hydrogen tank contains compressed hydrogen which it sends to the fuel cell system during vehicle operation.
11) The PEM fuel cell receives hydrogen which undergoes an electrochemical reaction with atmospheric oxygen resulting in electrical energy production.
12) The process generates water and heat as by-products while producing no harmful emissions.
13) The fuel cell generates direct current power which needs power conditioning because it does not meet traction requirements.
14) The fuel cell output voltage goes through a DC/DC converter which maintains stable voltage levels that match battery and inverter requirements.
15) The rechargeable battery functions as an energy storage system which stores surplus energy while delivering high power for acceleration and load changes.
16) The battery enables system startup and maintains operation stability during periods when the fuel cell takes time to respond.
17) The DC/AC inverter transforms regulated direct current power into alternating current power needed by the motor.
18) The BLDC motor receives AC power and transforms it into mechanical power which drives the wheel.
19) The combined fuel cell–battery architecture enables the fuel cell to function as a range extender which delivers extended driving distance and enhanced efficiency and dependable operation to urban electric two-wheelers.

VI. CONCLUSION

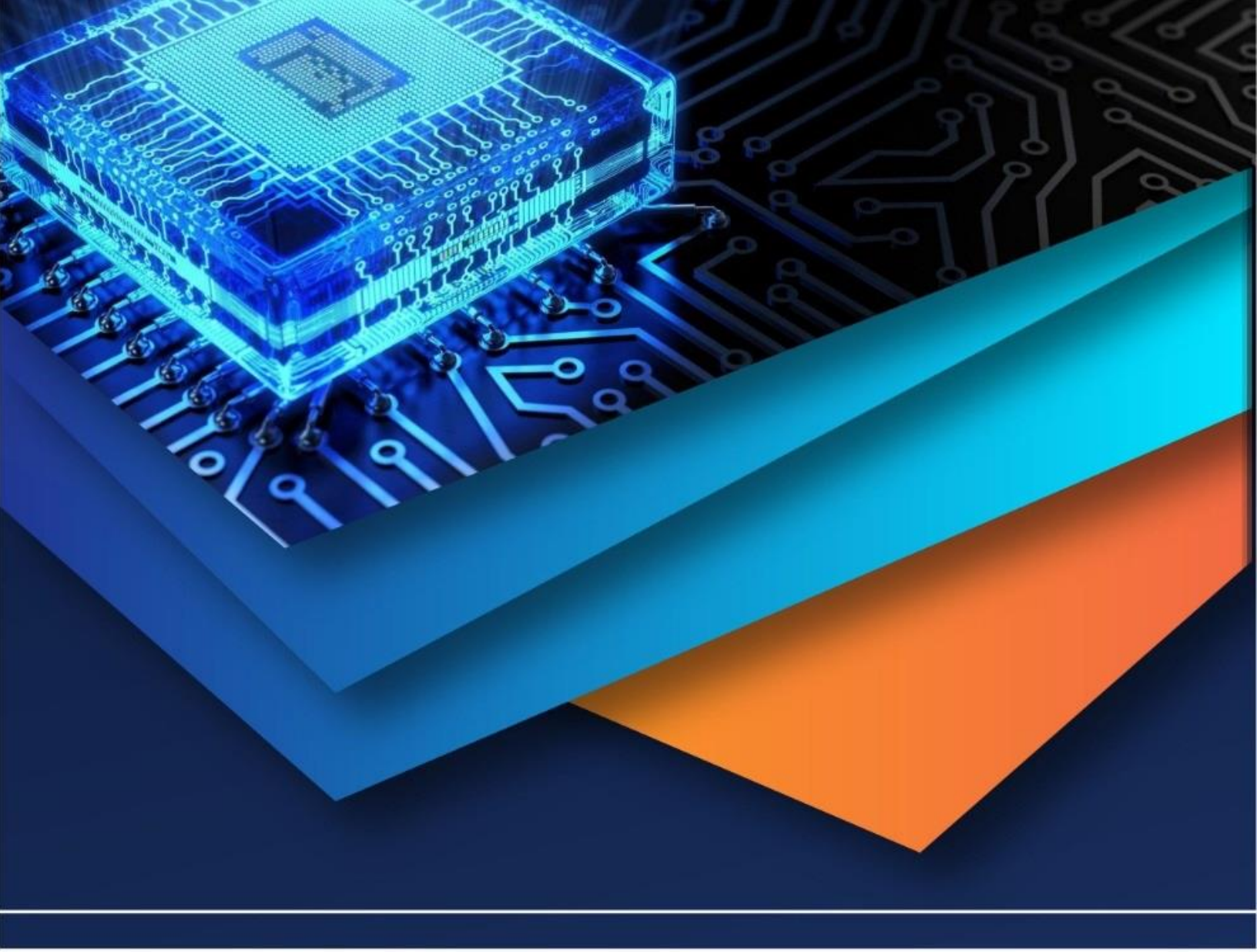
The review demonstrates that hydrogen fuel cell technology represents an effective system for achieving sustainable transportation solutions which apply to electric two-wheelers and lightweight mobility systems. Hydrogen fuel cells deliver multiple benefits because they produce no tailpipe emissions and they achieve high energy efficiency while enabling quick refueling and delivering a longer operational range than standard battery electric vehicles. The research shows that hybrid fuel cell-battery systems achieve their best performance when combining the nonstop power output of fuel cells with the rapid power delivery characteristics of batteries. The development of PEM fuel cell technology together with hydrogen storage systems and power electronic converters has made it easier to use fuel cells in small vehicle applications.

The research needs to investigate methods for decreasing costs and building necessary infrastructure while conducting actual tests in MATLAB software. The whole hydrogen fuel cell technology shows high capability to enable clean urban transportation systems while helping various worldwide efforts to decrease greenhouse gas emissions.

REFERENCES

[1] A. Kumar and S. Patel, “Hydrogen Fuel Cell Powered Two-Wheelers: A Review,” Energy Reports, 2023.
[2] R. Mohan and L. Das, “PEM Fuel Cell Technologies for Light Electric Vehicles,” International Journal of Hydrogen Energy, 2024.
[3] J. Rivera and M. Lopez, “Fuel Cell Range Extenders for Electric Motorcycles,” Sustainable Mobility Journal, 2023.
[4] T. Smith and H. Zhang, “Hybrid Fuel Cell–Battery Powertrains for Urban Mobility,” Applied Energy, 2024.
[5] P. Sharma and V. Singh, “Simulation of Hydrogen FC Powertrains Using MATLAB/Simulink,” Renewable Transport Research, 2022.
[6] R. Yamada and S. Ito, “Hydrogen Storage Solutions for Lightweight Vehicles,” Energy Storage Materials, 2023.
[7] F. Ahmed and G. Reza, “Evaluation of Fuel Cell Performance Under Dynamic Load Conditions,” Journal of Power Sources, 2024.
[8] K. Brown and M. O’Neil, “Drive Cycle Analysis for Two-Wheeler Electrification,” Transportation Energies, 2023.
[9] L. Choi and J. Park, “Advances in BLDC Motor Control for Fuel Cell Vehicles,” Electric Machines Review, 2022.
[10] D. Wilson and P. Hart, “Sustainability Potential of Hydrogen Mobility,” Clean Energy Technologies, 2024.
[11] I. Djunaedi, H. Wahyu, Sugiyatno, “Initiation of Hydrogen-Electric bike based on hybrid renewable hydrogen production,” in Proc. of 3rd Int. Conf. on Sustainable Energy Eng. and Appl., Bandung, Indonesia, 2015.
[12] H. Wahyu, I. Djunaedi, A. Oemry, A. Subhan, “Sepeda listrik berbasis sistem sel bahan bakar spfc berkekuatan 400 W,” in Prosiding Seminar Nasional Rekayasa Kimia dan Proses, Semarang, Indonesia, 2007.
[13] H. Revelation, N. Rusnaeni and A. Oemry, “Prospects using direct methanol fuel cells (DMFC) compared with solid polymer fuel cells hydrogen, DIP project final report-2003,” Research Center for Physics-LIPI, Bandung, 2003.
[14] EA Technology. (2000). Fuel Cell Niche Market Applications and Design Studies.
[15] U. Ofoma and C. Wu, “Design of a fuel cell powered UAV for environmental research,” presented at AIAA 3rd Unlimited Tech.l Conf. Workshop and Exhibit, California, USA, 2004.

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