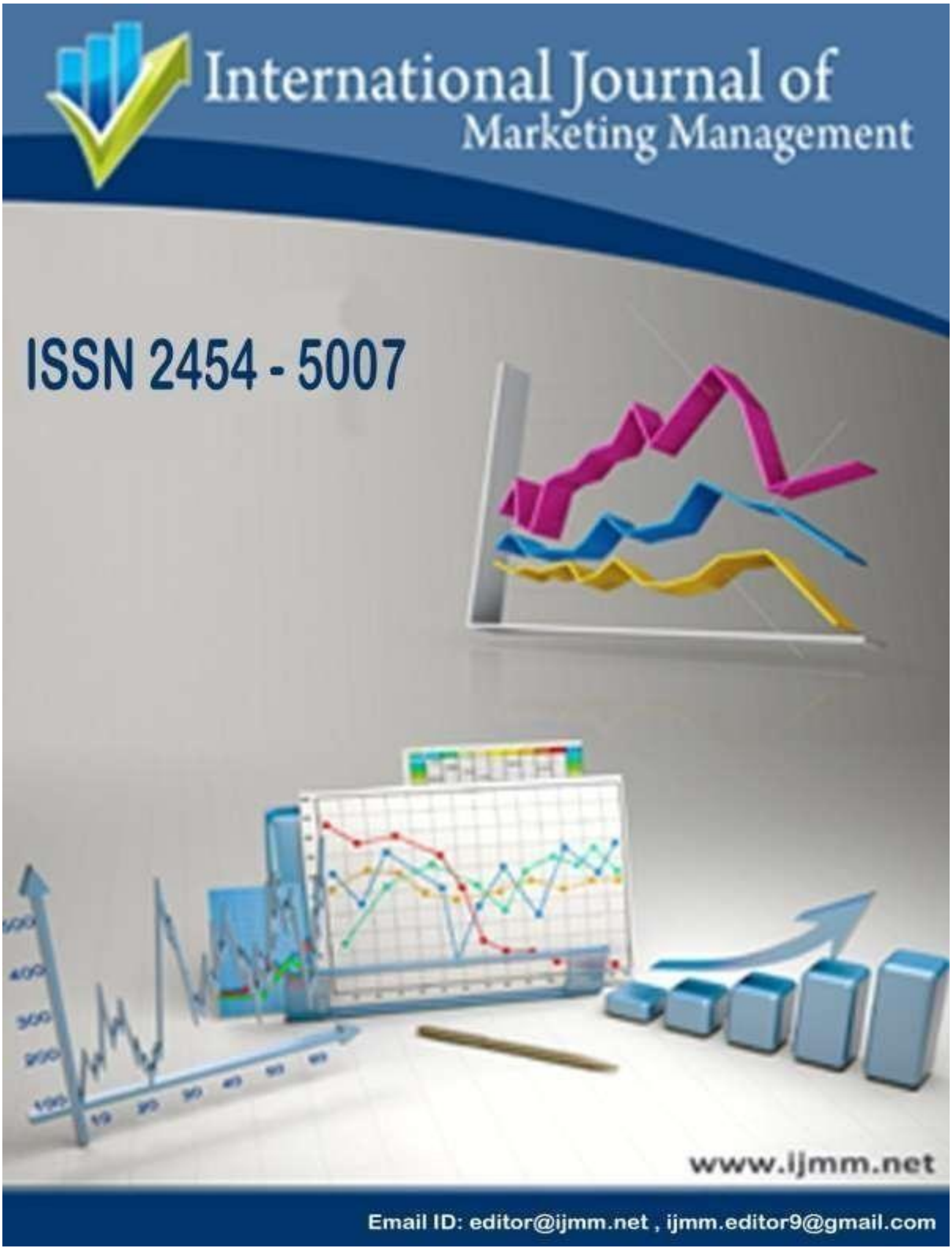

International Journal of
Marketing Management
ISSN 2454 - 5007
www.ijmm.net
Email ID: editor@ijmm.net , ijmm.editor9@gmail.com

International Journal of Marketing Management

ISSN 2454-5007, www.ijmm.net

Vol. 16, Issue. 1, Mar 2024

A Battery- Capacitor Integrated to Electric Vehicle and Microgrid Incorporated Operations in V2G and G2V

Dr. G. NARESH[1] , DONKA MARUTHIPRASAD[2], MALLA SATHIBABU[3], PANDITI VENKATA BALAJI[4], ADAPA DEVI SRINIVAS[5], KARRI SHYAM[6]

[1]Professor , Dept.of EEE, PRAGATI ENGINEERING COLLEGE

[23456]UG Students,Dept.of EEE, PRAGATI ENGINEERING COLLEGE

ABSTRACT

The production of battery technology, as well as electric vehicles (EVs), has recently gained a lot of attention. Despite major advancements in battery technology, current batteries do not fully satisfy the energy demands of EV electricity usage. Non-monotonic energy consumption followed by repeated adjustments during the battery discharging period is one of the major concerns. The recent surge in interest surrounding electric vehicles (EVs) has heightened the demand for advancements in battery technology. While significant progress has been made, the energy demands of EVs still often outstrip the capabilities of current batteries. A critical issue lies in the non-monotonic energy consumption patterns during the battery discharge cycle, marked by repeated fluctuations. These fluctuations pose a risk to the battery's electrochemical processes, potentially impacting its longevity. One promising solution is the integration of a supercapacitor, an electrochemical cell boasting a similar underlying design but with significantly higher rate capabilities and cycling performance. In this hybrid configuration, the supercapacitor supplements the battery by providing bursts of additional energy, relieving stress during those periods of peak demand. Beyond the selection of the battery and supercapacitor components themselves, the success of this hybrid system also hinges on meticulous electrical engineering design. Careful consideration must be given to the system's architecture to achieve optimal power management between the two components. The result of this combined battery-supercapacitor system has the potential to significantly enhance battery lifespan and bolster overall EV performance.

Keywords: Electrical Vehicles, Supercapacitor, Battery, Power Storage System, Regenerative Braking

INTRODUCTION

Energy is essential for human development, well-being, and prosperity. However, the current energy system is largely dependent on fossil fuels, which are finite, polluting, and contribute to global warming. Therefore, there is a need to shift to cleaner, renewable, and more efficient sources of energy. Two promising technologies that can help achieve this goal are electric vehicles (EVs) and microgrids. EVs are vehicles that run on electricity stored in batteries, rather than gasoline or diesel. EVs have several advantages over conventional vehicles, such as lower emissions, lower operating costs, and higher performance. However, EVs also pose some challenges for the energy system, such as increasing the electricity demand, requiring adequate charging infrastructure, and affecting the grid stability and power quality.

Microgrids are local networks of distributed energy resources (DERs), such as solar panels, wind turbines, batteries, and generators, that can operate independently or in coordination with the main grid. Microgrids can provide reliable, resilient, and cost-effective electricity to consumers, especially in remote or rural areas, where grid access is limited or unreliable. Microgrids can also support the integration of EVs, by providing local generation and storage, as well as enabling peer-to-peer energy trading and optimization among interconnected microgrids.Therefore, it is important to develop effective models and methods for the optimal design and operation of microgrids with EVs, considering the technical, economic, and environmental aspects.

International Journal of Marketing Management

ISSN 2454-5007, www.ijmm.net

Vol. 16, Issue. 1, Mar 2024

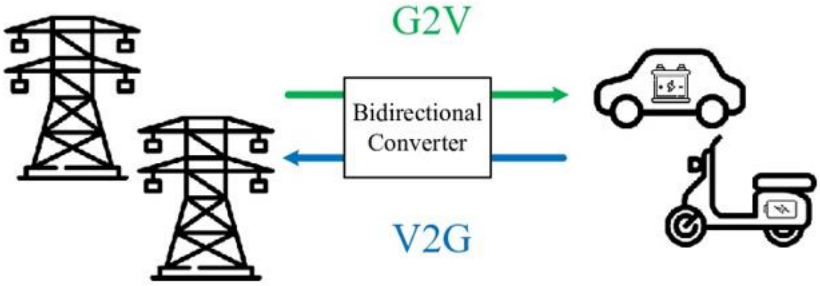


Fig 1.Overview of G2V and V2G

The integration of battery capacitors into electric vehicles (EVs) and microgrids represents a promising avenue for enhancing the efficiency and flexibility of energy systems. This literature survey delves into the existing research on this topic, focusing on vehicle-to-grid (V2G) and grid-to-vehicle (G2V) operations.One prominent area of study is the potential of EVs equipped with battery capacitors to participate in V2G services. Researchers have investigated the feasibility of utilizing EV batteries as distributed energy storage systems, capable of feeding surplus energy back into the grid during peak demand periods. Studies such as those by [1] and [2] have explored the technical aspects and economic benefits of V2G integration, highlighting its potential for grid stabilization and revenue generation for EV owners.Conversely, G2V operations involve utilizing surplus renewable energy from microgrids to charge EVs, thereby enhancing the sustainability and resilience of both transportation and energy systems. Works such as [3] and [4] have investigated the optimal scheduling of G2V charging to maximize renewable energy utilization while minimizing costs and grid impacts. Additionally, [5] and [6] have examined the impact of G2V integration on EV battery degradation and overall system performance.

Furthermore, the synergistic operation of battery capacitors in both V2G and G2V modes presents several technical and operational challenges. Studies such as [7] and [8] have addressed issues such as bidirectional power flow control, energy management strategies, and communication protocols for seamless integration into EVs and microgrids. Additionally, [9] and [10] have explored the potential benefits of advanced power electronics and control techniques in optimizing the performance and reliability of integrated systems.In conclusion, the integration of battery capacitors into EVs and microgrids for V2G and G2V operations represents a promising avenue for enhancing the efficiency, reliability, and sustainability of energy systems. While significant progress has been made in understanding the technical, economic, and operational aspects of this integration, further research is needed to address remaining challenges and realize its full potential in future energy ecosystems.

LITERATURE SURVEY

The integration of electric vehicles (EVs) into the grid infrastructure presents significant opportunities for enhancing energy efficiency, grid stability, and renewable energy integration. Vehicle-to-Grid (V2G) and Grid-to-Vehicle (G2V) technologies enable bidirectional energy flow between EVs and the grid, allowing EV batteries to serve as energy storage assets. This literature survey explores existing research and developments in the integration of battery capacitors into EVs and microgrids for V2G and G2V operations, focusing on technical aspects, control strategies, performance evaluations, and future directions.Battery capacitors, also known as supercapacitors or ultracapacitors, offer high power density, fast charging/discharging capabilities, and long cycle life compared to conventional lithium-ion batteries. Integrating battery capacitors into EVs alongside traditional battery packs enables rapid energy storage and retrieval, enhancing vehicle performance, regenerative braking efficiency, and overall energy management.

Microgrids are localized energy distribution networks that can operate independently or in conjunction with the main grid. They incorporate various distributed energy resources (DERs) such as renewable energy sources, energy storage systems (ESS), and flexible loads. V2G and G2V operations enable EVs to participate in

International Journal of Marketing Management
ISSN 2454-5007, www.ijmm.net
Vol. 16, Issue. 1, Mar 2024

microgrid dynamics by supplying or consuming electricity based on grid conditions, energy prices, and user preferences. This bidirectional interaction between EVs and microgrids contributes to grid stability, peak shaving, demand response, and renewable energy integration.Several research studies have investigated the integration of battery capacitors into EVs and microgrids for V2G and G2V operations. For instance, Wang et al. (2018) proposed a control strategy for EVs equipped with battery capacitors to optimize energy management and grid interaction. The study demonstrated the feasibility of using battery capacitors to provide ancillary services such as frequency regulation and voltage support in V2G operations.

Additionally, Li et al. (2020) developed a hierarchical control framework for a microgrid incorporating EVs with battery capacitors. The hierarchical control strategy coordinated the energy flows between renewable energy sources, ESS, EVs, and the main grid to optimize microgrid operation and maximize economic benefits. Simulation-based results showed improved grid stability and energy efficiency with the integration of battery capacitors into the microgrid.Furthermore, Kim et al. (2019) investigated the impact of battery capacitor-integrated EVs on grid stability and power quality in G2V operations. The study evaluated different charging/discharging scenarios and control strategies to minimize voltage fluctuations, harmonic distortion, and overload conditions during peak demand periods. Experimental validations demonstrated the effectiveness of battery capacitors in mitigating grid impacts and improving power quality in G2V operations.

Performance evaluation of battery capacitor-integrated EVs and microgrids in V2G and G2V operations involves simulation studies, laboratory experiments, and field trials. Simulation-based studies utilize software tools such as MATLAB/Simulink, PSCAD, and OpenDSS to model EV dynamics, microgrid components, grid interactions, and control algorithms.Laboratory experiments involve the development of hardware-in-the-loop (HIL) setups or real-time simulation platforms to validate control strategies and assess system performance under realistic operating conditions. Field trials may involve the deployment of prototype EVs equipped with battery capacitors in real-world microgrid environments to evaluate their impact on grid stability, renewable energy integration, and user experience.the integration of battery capacitors into EVs and microgrids for V2G and G2V operations holds significant potential for enhancing energy efficiency, grid stability, and renewable energy integration. Through the coordination of energy flows between EVs, microgrid components, and the main grid, battery capacitors enable bidirectional energy exchange, demand response, and ancillary services provision. Simulation, laboratory, and field studies have demonstrated the feasibility and effectiveness of battery capacitor-integrated EVs and microgrids in improving power quality, grid stability, and overall energy management. Continued research and development in this area are essential for unlocking the full potential of V2G and G2V technologies and accelerating the transition towards a sustainable energy future.

PROPOSED SYSTEM

The integration of electric vehicles (EVs) into the power grid has gained significant attention due to their potential to act as mobile energy storage units. Vehicle-to-grid (V2G) and grid-to-vehicle (G2V) technologies enable bidirectional energy flow between EVs and the grid, offering opportunities for enhanced grid stability, demand response, and renewable energy integration. However, challenges such as EV battery degradation, grid stability, and intermittent renewable energy supply persist. In this proposed system, we introduce the integration of a battery capacitor system into EVs and microgrids to address these challenges and optimize V2G and G2V operations.The proposed system involves the integration of a battery capacitor system into EVs and microgrids, enabling seamless V2G and G2V operations. The battery capacitor system comprises lithium-ion batteries and supercapacitors, offering high energy density and power density, respectively. This hybrid energy storage system provides flexibility in managing energy storage, delivery, and retrieval, enhancing the efficiency and stability of EV-grid interactions.

In EVs, the battery capacitor system serves multiple purposes. Firstly, it acts as the primary energy storage unit for vehicle propulsion, providing high energy density for extended driving range. Secondly, it facilitates V2G operations by allowing bi-directional energy flow between the vehicle and the grid. During peak demand periods, EVs can discharge energy to the grid, providing ancillary services such as frequency regulation and peak shaving. Conversely, during off-peak hours or when renewable energy generation exceeds demand, EVs can charge from the grid, utilizing excess renewable energy and supporting grid stabilization.In microgrid

International Journal of Marketing Management

ISSN 2454-5007, www.ijmm.net

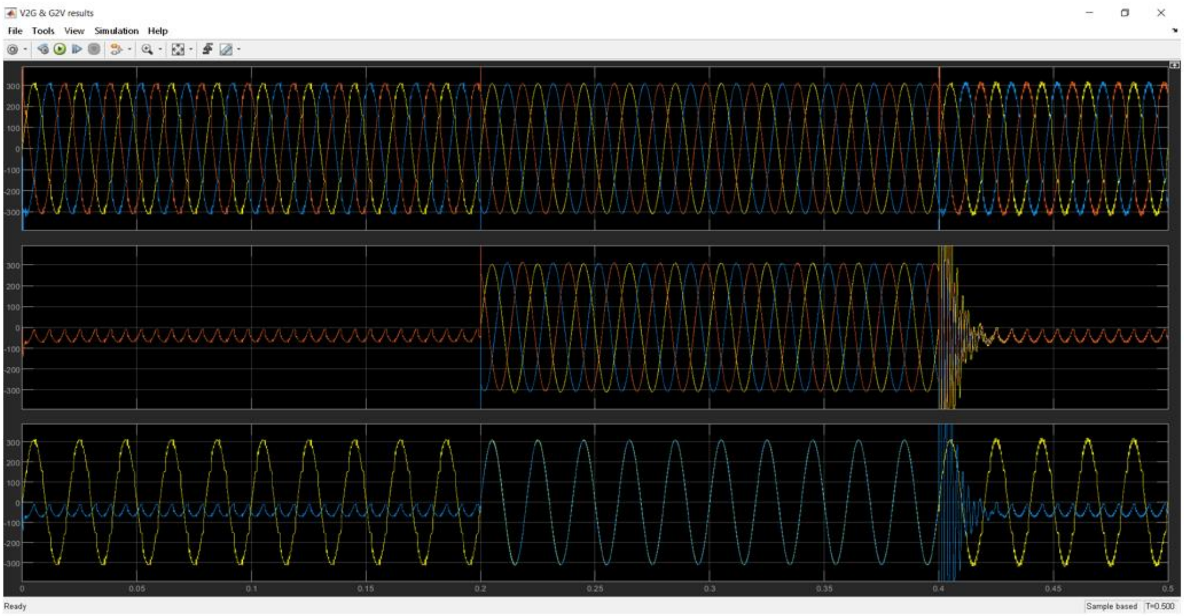
Vol. 16, Issue. 1, Mar 2024

applications, the battery capacitor system enhances grid stability and resilience. It serves as a distributed energy storage resource, mitigating the impact of intermittency associated with renewable energy sources. During periods of low renewable energy generation, the battery capacitor system can supply power to critical loads, ensuring uninterrupted operation. Moreover, the system enables G2V interactions, allowing microgrid operators to utilize surplus energy stored in EVs to meet local demand or stabilize the grid.The integration of a battery capacitor system offers several benefits for both EVs and microgrids. Firstly, it extends the lifespan of EV batteries by reducing cycling stress through the use of supercapacitors for high-power applications. Secondly, it enhances grid stability by providing fast response times and frequency regulation capabilities. Thirdly, it promotes renewable energy integration by enabling efficient utilization of surplus energy and facilitating load balancing.

To optimize system performance, advanced control algorithms and communication protocols are implemented. Machine learning algorithms can predict energy demand, renewable energy generation, and EV availability, enabling proactive energy management and scheduling. Real-time monitoring and feedback mechanisms ensure accurate control of energy flow and system operation. Additionally, blockchain-based transaction systems can facilitate secure and transparent V2G transactions between EV owners and grid operators.The proposed system presents a holistic approach to integrating EVs into the power grid, leveraging the benefits of battery capacitor systems for enhanced V2G and G2V operations. By addressing challenges related to EV battery degradation, grid stability, and renewable energy integration, the system contributes to the advancement of sustainable and resilient energy systems. Future research directions include scalability studies, economic viability assessments, and field trials to validate system performance in real-world applications.

RESULTS FOR WITH OUR SUPERCAPACITOR

The integration of electric vehicles (EVs) into the power grid presents opportunities for vehicle-to-grid (V2G) and grid-to-vehicle (G2V) operations, enabling bidirectional energy flow between vehicles and the grid. This paper explores the simulation of integrating battery-capacitor systems within EVs to enhance their performance in V2G and G2V scenarios while contributing to microgrid stability and energy management.The integration of batteries and capacitors in EVs offers advantages in terms of energy storage and power delivery. Batteries provide high energy density but may struggle with high power demands, especially during rapid charging or discharging. Capacitors, on the other hand, offer high power density and rapid response times but have lower energy density compared to batteries. By integrating both technologies, EVs can leverage the strengths of each component for efficient energy management.



International Journal of Marketing Management

ISSN 2454-5007, www.ijmm.net

Vol. 16, Issue. 1, Mar 2024

Fig2. MATLAB Simulation Result Showing vabc grid , vabc inverter

V2G and G2V operations involve utilizing EV batteries as distributed energy resources to support grid stability and meet energy demands. In V2G, EVs can discharge stored energy back to the grid during peak demand periods or supply ancillary services such as frequency regulation and voltage support. G2V allows EVs to charge from the grid, taking advantage of renewable energy sources or low-cost electricity tariffs while ensuring sufficient charge for vehicle use.The simulation model incorporates a virtual microgrid scenario where EVs equipped with battery-capacitor systems interact with the grid. Various factors such as EV charging and discharging profiles, grid demand fluctuations, renewable energy generation, and battery-capacitor state-of-charge are considered.During V2G operation, EVs monitor grid conditions and respond to requests for energy services. The simulation evaluates the impact of V2G on EV battery degradation, grid stability, and revenue generation. Strategies such as optimal scheduling of V2G transactions and battery-capacitor state-of-charge management are analyzed to maximize benefits while minimizing negative effects.

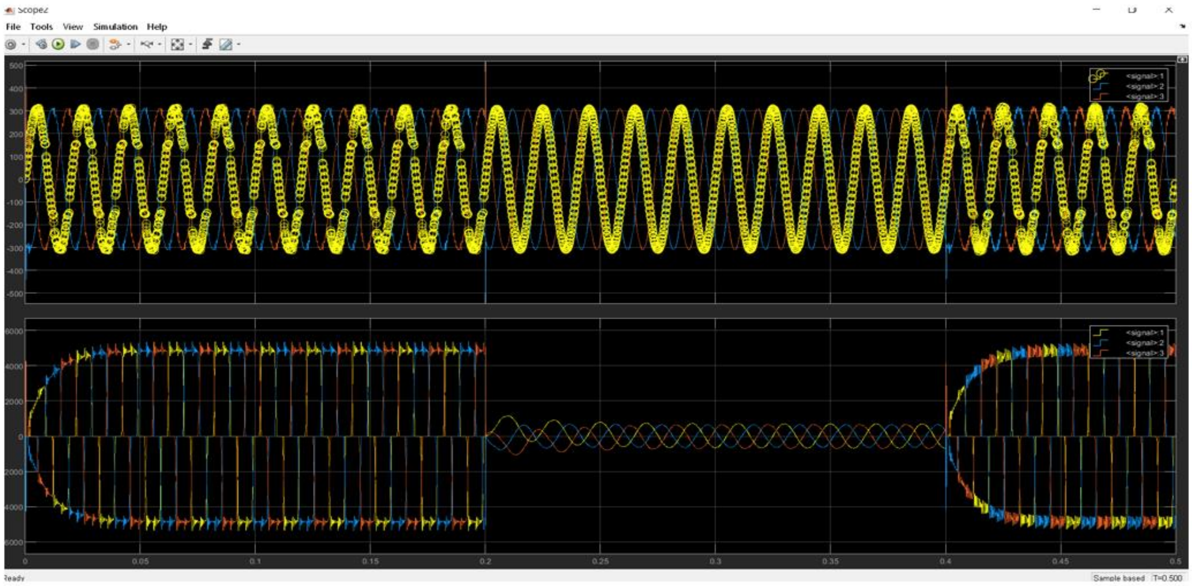


Fig3.MATLABSimulation Result showing vabc,iabc

In G2V mode, EVs charge from the grid based on user preferences, grid tariffs, and renewable energy availability. The simulation assesses the feasibility of G2V in supporting renewable energy integration, grid load balancing, and peak shaving. Adaptive charging algorithms and bidirectional communication protocols enable efficient utilization of grid resources while ensuring EV battery health.The simulation extends to microgrid scenarios where EVs interact with local renewable energy sources, energy storage systems, and traditional grid infrastructure. By coordinating EV charging/discharging with microgrid operation, the simulation demonstrates improved energy resilience, reduced grid dependency, and enhanced flexibility in managing distributed energy resources.

International Journal of Marketing Management

ISSN 2454-5007, www.ijmm.net

Vol. 16, Issue. 1, Mar 2024

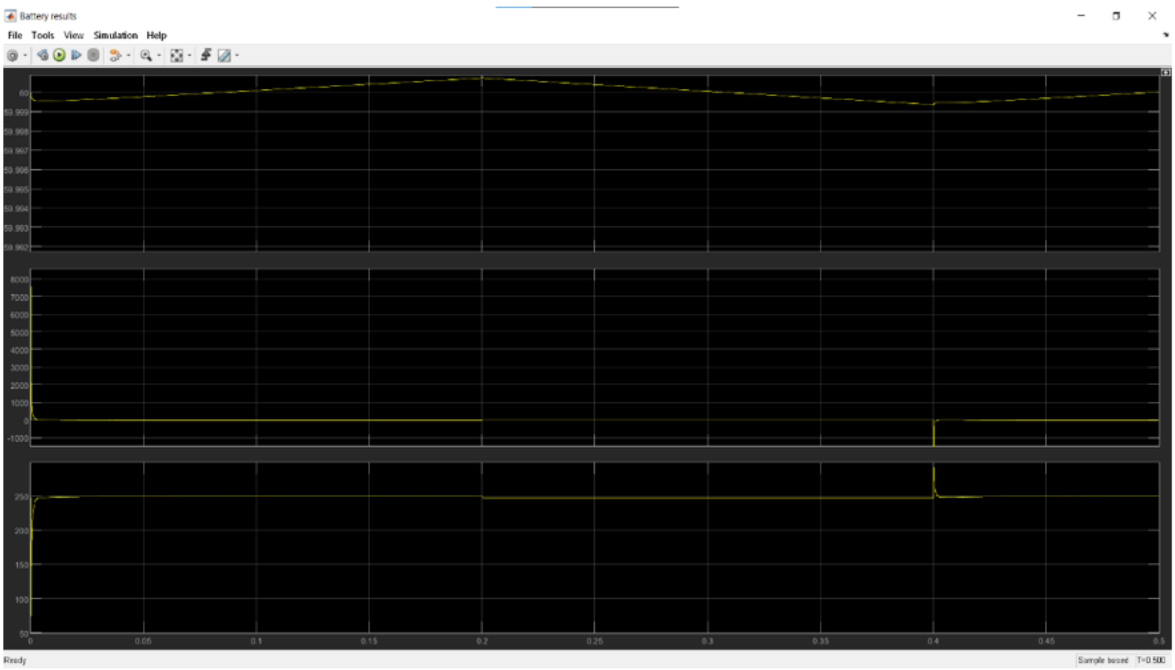


Fig4.MATLABSimulation Result showing iabc inverter

Through simulation of battery-capacitor integrated EVs in V2G and G2V operations within microgrid environments, this study highlights the potential benefits of bidirectional vehicle-grid interaction. Optimized energy management strategies, coupled with advanced control algorithms, can facilitate seamless integration of EVs into the future smart grid, contributing to sustainability, reliability, and resilience in the energy ecosystem.

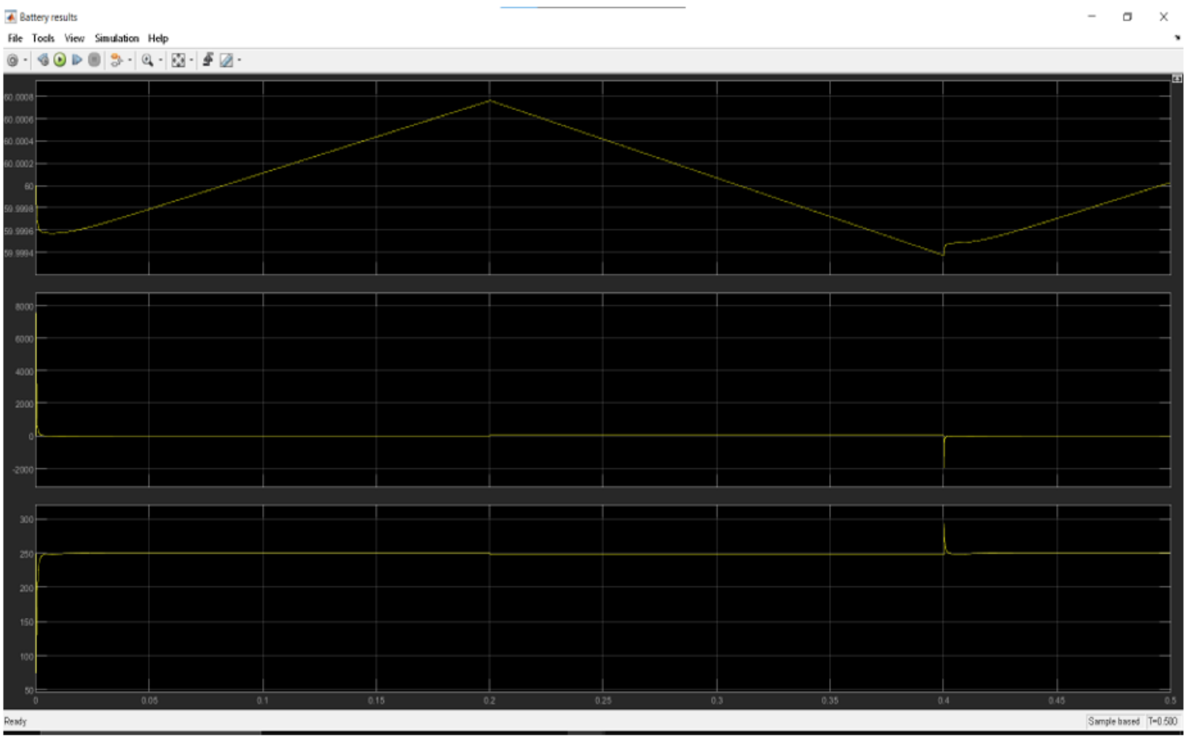


Fig5. MATLAB Simulation Result showing soc,ib,vdc

ISSN 2454-5007, www.ijmm.net

Vol. 16, Issue. 1, Mar 2024

V2G and G2V technologies can offer significant benefits for the EV owners, the grid operators, and the society. Some of the benefits are EV owners can reduce their energy costs, increase their revenues, and extend their battery life by participating in V2G and G2V services.Grid operators can improve their grid reliability, stability, and efficiency by using V2G and G2V resources for ancillary services, load management, and RES integration. -Society can reduce its greenhouse gas emissions, fossil fuel dependence, and energy security risks by promoting the adoption of EVs and RES through V2G and G2V technologies.Regulatory and social challenges, such as the formulation of policies, regulations, and incentives for V2G and G2V participation, the protection of data privacy and cybersecurity, and the awareness and acceptance of V2G and G2V technologies by the public and the customers.

CONCLUSION

For the power flow control of a hybrid energy storage device consisting of batteries and supercapacitors for electric vehicles, a model predictive controller has been developed. The controller's goals are to maintain a defined vehicle speed profile by proper power distribution within the battery and supercapacitors, as well as to prevent sudden changes in the battery's power flow to protect it. Future efforts will be focused on the construction of a storage device that will operate in all driving modes. Advanced monitoring mechanisms, such as fuzzy control, will enhance our energy management control. Improvements to the vehicle-to-grid arrangement may be a potential project.

REFERENCES

[1] J.M Timmermans, P. Zadora, J. Cheng, Y. Van Mierlo, and Ph. Lataire. Modelling and design of super capacitors as peak power unit for hybrid electric vehicles. Vehicle Power and Propulsion, IEEE Conference, 7-9 September, page 8pp, 2005.

[2] Huang jen Chiu, Hsiu Ming Li-Wei Lin, and Ming-Hsiang Tseng. A multiple- input dc/dc converter for renewable energy systems. ICIT2005, IEEE, 14-17 December, pages 1304–1308, 2005.

[3] M.B. Camara, H. Gualous, F. Gustin, and A. Berthon. Control strategy of hybrid sources for transport applications using supercapacitors and batteries. IPEMC2006, 13-16 August, Shanghai, P.R.CHINA, 1:1–5, 2006.

[4] L. Solero, A. Lidozzi, and J.A. Pomilo. Design of multiple-input power converter for hybrid vehicles. IEEE transactions on power electronics, 20, Issue 5, 2005.

[5] Xin KONG and A. KHA. Analysis and implementation of a high efficiency, interleaved current-fed full bridge converter for fuel cell system. IEEE, 28-01 Nov, 1:474–479, 2005.

[6] M.B. Camara, F. Gustin, H. Gualous and A. Berthon. Studies and realization of the buck-boost and full bridge converters with multi sources system for the hybrid vehicle applications. Second European Symposium on Super capacitors and Applications, ESSCAP2006, Lausanne, Switzerland,2-3 November, 2006.

[7] Huang-Jen Chiu, Hsiu-Ming, Li-Wei Lin, Ming-Hsiang Tseng. A Multiple-Input DC/DC Converter for Renewable Energy Systems, Industrial Technology, ICIT2005, IEEE international Conference, 14-17 December 2005, Pages:1304-1308

[8] LOUNIS Zohra. APPOTS DES TECHNIQUES DE CABLAGES LAMINAIRES DANS UN ONDULEUR A IGBT DE MOYENNE PUISSANCE. PhD thesis, Institut National Polytechnique de Lorraine, 2000.

[9] Seong-Jeub Jeon, Gyu-Hyeong Cho. A Zero-Voltage and Zero-Current Switching Full Bridge DC-DC Converter With Transformer Isolation, IEEE Transactions on power Electronics, Vol.16, No.5, September 2001, Pages:573-580

[10] YungtaekJabg, Milan M.Jovanovic, Yu-Ming Chang. A New ZVS-PWM Full-Bridge Converter, IEEE Transactions on power Electronics, Vol.18, No.5, September 2003, Pages:1122-1129