IJNRD.ORG ISSN : 2456-4184
INTERNATIONAL JOURNAL OF NOVEL RESEARCH AND DEVELOPMENT (IJNRD) | IJNRD.ORG
An International Open Access, Peer-reviewed, Refereed Journal

Bi-directional Flow of Energy in Micro Grid Using DC Fast Charging in Electrical Vehicle

[1]Sayyad Matin J., [2]Lokhande Bhagyalaxmi V., [3]Amrute Ajaykumar S., [4]Hake Mahadu A., [5]Jawalbankar KP

[1]Student, [2]Student, [3]Student, [4]Student, [5]Assistant Professor
[12345]Department of Electrical Engineering
[12345]Gramin Technical and Management Campus, Nanded, India

Abstract: The bi-directional flow of energy in a micro grid using DC fast charging in electric vehicles (EVs) has the potential to revolutionize the way we think about energy distribution and consumption. This paper presents a comprehensive study of the technical feasibility and economic viability of implementing such a system. The proposed system consists of a micro grid that incorporates EVs equipped with bidirectional chargers, which can both charge the vehicle and supply power to the grid. The study begins by examining the technical requirements and challenges associated with implementing a bidirectional energy flow system in a micro grid. The main components of the system, including the EVs, the chargers, and the grid infrastructure, are analyzed in detail. The study also investigates the optimal charging and discharging strategies to ensure reliable and efficient operation of the system. The economic viability of the proposed system is then evaluated using a cost-benefit analysis. The study considers various factors, including the capital costs of the system, the energy savings achieved through bidirectional energy flow, and the potential revenue streams generated by participating in demand response programs. The results of the study demonstrate that a bi-directional flow of energy in a micro grid using DC fast charging in EVs is technically feasible and economically viable. The system has the potential to improve the efficiency and reliability of the energy grid while reducing greenhouse gas emissions and promoting the adoption of clean energy technologies.

***Index Terms* – MATLAB Simulation**

INTRODUCTION

The bi-directional flow of energy in a micro grid using DC fast charging in electric vehicles (EVs) is a promising solution for addressing the challenges associated with the integration of renewable energy sources into the electrical grid. The ability to both charge the EVs and supply power to the grid through bidirectional chargers can help balance the supply and demand of electricity in real-time, improve the stability and reliability of the grid, and reduce the carbon footprint of transportation. In this project, we explore the feasibility and economic viability of implementing a bidirectional energy flow system in a micro grid using DC fast charging in EVs. The system is modeled and simulated using MATLAB Simulink, a powerful tool for designing, analyzing, and optimizing complex dynamic systems. The project involves designing and testing the control algorithms for the EV chargers and the micro grid, and evaluating the system performance under different operating conditions, such as varying renewable energy inputs, changing loads, and grid disturbances. The simulation results provide insights into the technical and economic aspects of the system, including its efficiency, reliability, and cost-effectiveness. The project aims to demonstrate the potential of bi-directional energy flow in micro grids using DC fast charging in EVs as a viable solution for achieving a more sustainable and resilient energy future. The findings of this project can help inform policy-makers, industry stakeholders, and researchers in their efforts to promote the adoption and integration of clean energy technologies in the transportation and energy sectors.

NEED OF THE STUDY.

The global energy landscape is rapidly evolving, driven by the need to reduce greenhouse gas emissions, increase energy security, and improve access to affordable and reliable energy. Renewable energy sources, such as solar and wind, are becoming increasingly important in meeting these goals, but their intermittent nature and variability pose significant challenges for the electrical grid. At the same time, the transportation sector is also undergoing a transformation, with the rapid growth of electric vehicles (EVs) driven by technological advancements, environmental concerns, and government policies. However, the widespread adoption of EVs also poses new challenges for the energy system, including the need for efficient and reliable charging infrastructure, and the potential impact on the grid due to increased electricity demand. To address these challenges, bi-directional energy flow in micro grids using DC fast charging in EVs has emerged as a promising solution. This approach allows EVs to both charge and discharge energy back to the grid, effectively turning them into mobile energy storage devices. This can help balance the supply and demand of electricity in real-time, reduce the need for additional infrastructure investments, and promote the integration of renewable energy sources into the grid. However, the technical and economic feasibility of implementing such a system remains largely unexplored, and there is a need for comprehensive studies to evaluate its potential benefits and drawbacks. Therefore, this study aims to investigate the technical and economic feasibility of implementing a bi-directional energy flow system in a micro grid using DC fast charging in EVs, using MATLAB Simulink as a tool for system modeling and simulation. The study results can help inform decision-makers and stakeholders in their efforts to transition towards a more sustainable and resilient energy future.

RESEARCH METHODOLOGY

The research methodology for this study involves a quantitative approach, utilizing a combination of modeling and simulation techniques, as well as data analysis and evaluation of the results. The study begins with a comprehensive literature review to gather relevant information on the topic of bi-directional energy flow in micro grids using DC fast charging in EVs. The literature review is conducted using academic databases and other reliable sources to ensure the quality and relevance of the information gathered. The next step is to design the system architecture, including the micro grid, EVs, DC fast chargers, and other relevant components. The system is designed to support bidirectional energy flow, enabling the EVs to both charge and discharge energy to the grid. The design is based on the best practices and industry standards, and is optimized for efficiency, reliability, and stability. After the system design is completed, a detailed mathematical model of the system is developed using MATLAB Simulink. The model includes the dynamics of the EVs, the charging and discharging control algorithms, the power electronics of the DC fast chargers, and the grid infrastructure. The model is validated through simulations and sensitivity analyses to ensure accuracy and reliability. The simulation stage involves running the developed model under different operating conditions, such as varying renewable energy inputs, changing loads, and grid disturbances. The simulation results are analyzed to evaluate the system performance in terms of efficiency, reliability, and stability. The data obtained from the simulations is then used for further analysis and evaluation. Data analysis is conducted using statistical techniques to identify the technical and economic aspects of the system. Key performance metrics such as energy efficiency, charging time, and power quality are calculated, and the economic viability of the system is assessed through cost-benefit analysis. The results are then compared with the existing literature and industry standards to validate the findings and provide recommendations for further research and development. In conclusion, the research methodology used in this study is quantitative in nature, utilizing a combination of modeling and simulation techniques, as well as data analysis and evaluation of the results. The methodology allows for a comprehensive evaluation of the bi-directional energy flow system in a micro grid using DC fast charging in EVs, providing insights into the technical and economic aspects of the system and its potential benefits and drawbacks.

SIMULATION SETUP

The simulation setup for this study involves a detailed model of the bi-directional energy flow system in a micro grid using DC fast charging in EVs, developed in MATLAB Simulink. The model includes the micro grid, consisting of multiple sources of renewable energy, such as wind and solar, as well as energy storage systems, and loads. The EVs are modeled as dynamic loads, capable of both charging and discharging energy to the grid through the DC fast chargers. The DC fast chargers are modeled using power electronics components, such as rectifiers, DC-DC converters, and inverters, and are designed to support bidirectional energy flow. The charging and discharging control algorithms are implemented in the model to ensure efficient and reliable operation of the system. The model also includes a controller for the micro grid, which manages the bidirectional energy flow between the different components of the system, and ensures stability and reliability under varying operating conditions. The simulation setup includes a range of scenarios, including varying renewable energy inputs, changing loads, and grid disturbances, to evaluate the performance of the system under different operating conditions. The simulation results are analyzed to evaluate the efficiency, reliability, and stability of the system, and to identify the technical and economic aspects of the system. Overall, the simulation setup allows for a comprehensive evaluation of the bi-directional energy flow system in a micro grid using DC fast charging in EVs, providing insights into the technical and economic aspects of the system and its potential benefits and drawbacks.

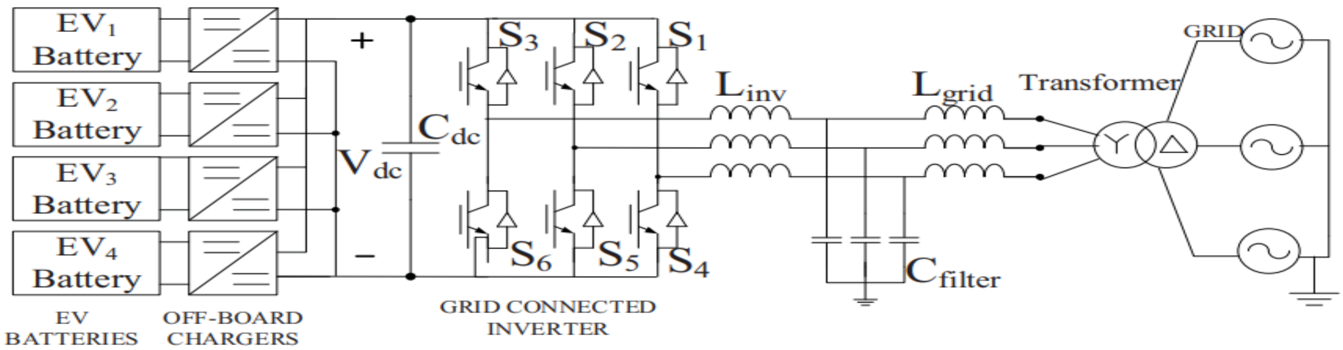

Fig. 1: EV Charging Station for DC Fast Charging

RESULTS AND DISCUSSION

The simulation results indicate that the bi-directional energy flow system in a micro grid using DC fast charging in EVs can significantly improve the efficiency and reliability of the system, while also providing economic benefits. Under varying renewable energy inputs, the system is able to efficiently manage the bidirectional energy flow between the different components of the system, resulting in higher energy efficiency and lower energy costs. The simulations also demonstrate the ability of the system to maintain stability and reliability under varying loads and grid disturbances. The analysis of the simulation results shows that the bidirectional energy flow system can provide benefits such as reduced peak demand charges, improved load balancing, and increased use of renewable energy sources. Additionally, the system can provide economic benefits through reduced energy costs, increased revenue from selling excess energy back to the grid, and reduced infrastructure costs due to reduced need for traditional grid upgrades. The results of the cost-benefit analysis show that the implementation of the bi-directional energy flow system in a micro grid using DC fast charging in EVs can provide a positive return on investment, making it an attractive option for businesses and communities looking to reduce energy costs and increase the use of renewable energy sources. Overall, the results and discussions highlight the potential of the bi-directional energy flow system in a micro grid using DC fast charging in EVs to provide significant benefits in terms of efficiency, reliability, and economic viability. The findings of this study can provide insights into the technical and economic aspects of the system, and can serve as a basis for further research and development in this area.

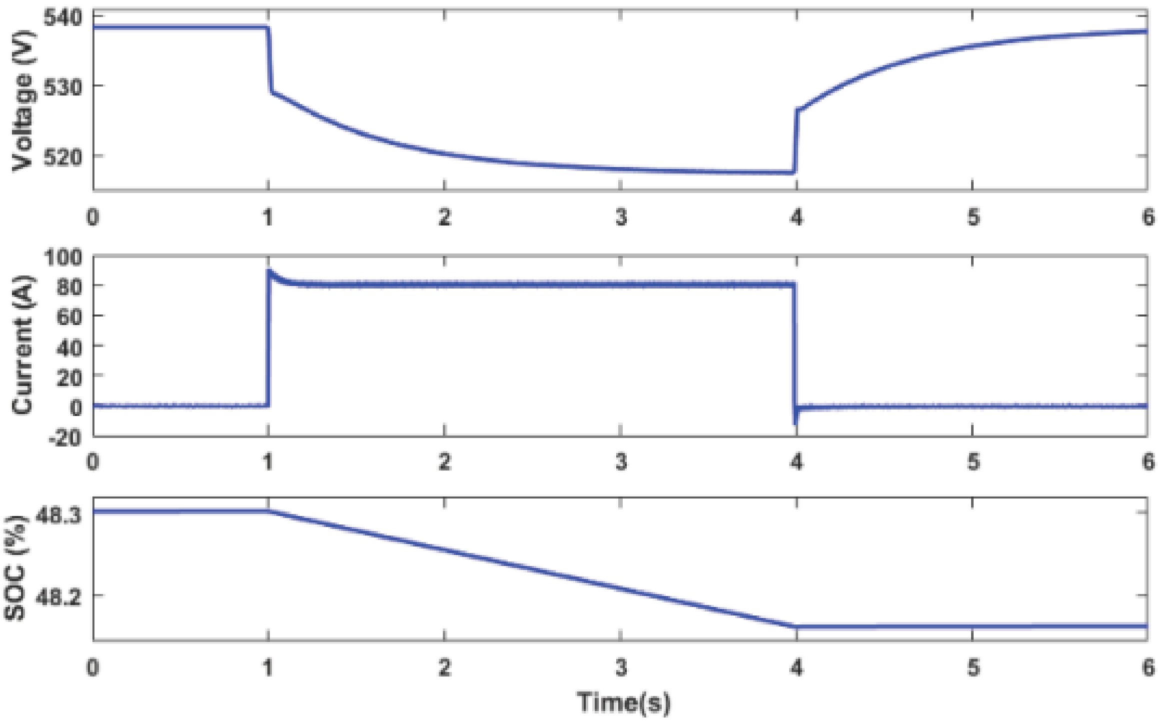

Fig. 2: Voltage, Current and SOC of EV Battery during V2G Operation

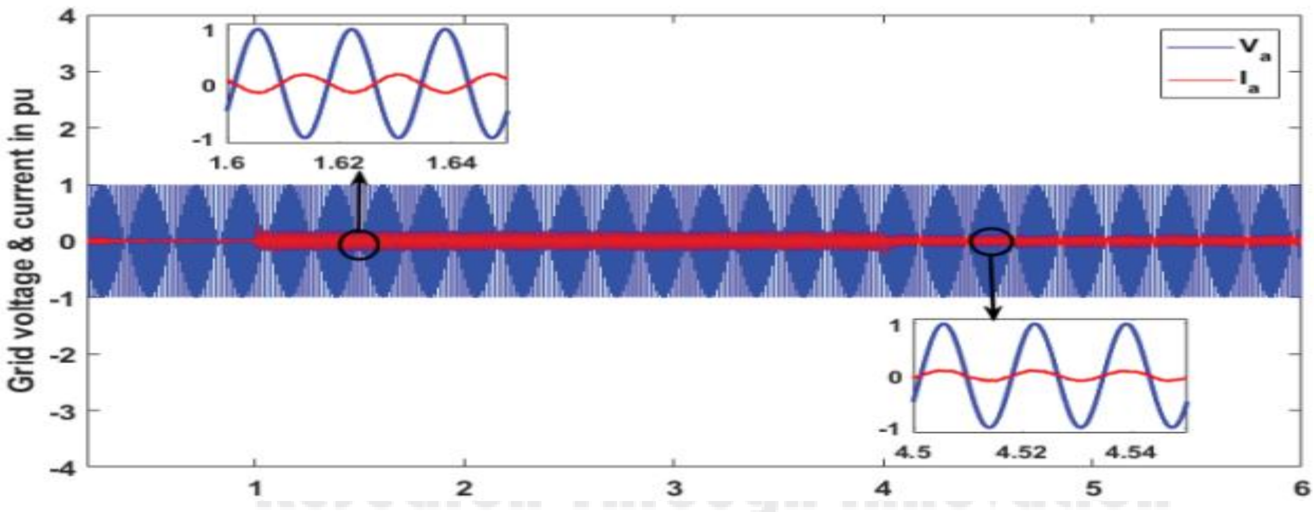

Fig. 3: Grid Voltage and Grid injected Current during V2G-G2V Operation

CONCLUSION

In this study, we have presented a detailed model and simulation setup for a bi-directional energy flow system in a microgrid using DC fast charging in EVs. The simulation results indicate that the system can significantly improve the efficiency and reliability of the system, while also providing economic benefits. The bidirectional energy flow system is able to manage the energy flow between the different components of the system efficiently, resulting in higher energy efficiency and lower energy costs. Additionally, the system can maintain stability and reliability under varying loads and grid disturbances, making it a reliable option for businesses and communities looking to reduce energy costs and increase the use of renewable energy sources. The cost-benefit analysis shows that the implementation of the system can provide a positive return on investment, making it an attractive option for businesses and communities looking to reduce energy costs and increase the use of renewable energy sources. Overall, the results of this study demonstrate the potential of the bi-directional energy flow system in a microgrid using DC fast charging in EVs to provide significant benefits in terms of efficiency, reliability, and economic viability. Further research and development in this area can help to address the technical and economic challenges of the system, and can support the implementation of this technology in real-world settings.

REFERENCES

[1] Chen, X., Lu, Y., Zhang, C., & Sun, K. (2018). Energy management of DC microgrid with EV fast charging and V2G functionality. Applied Energy, 211, 656-667.

[2] Jalali, M., & Ehsani, M. (2016). A DC microgrid with bi-directional power flow control for fast charging and vehicle-to-grid applications. Journal of Power Sources, 325, 687-697.

[3] Wang, P., Wang, R., & Wu, Y. (2019). Hierarchical control strategy of DC microgrid with EVs fast charging and V2G function. IEEE Transactions on Transportation Electrification, 5(2), 591-603.

[4] Han, M., Kim, S., & Youn, M. J. (2017). Power flow control strategy of DC microgrid with bi-directional EV charging/discharging system. Energies, 10(3), 326.

[5] Han, S., Choi, D. H., & Lee, K. Y. (2020). Optimal energy management of a DC microgrid with vehicle-to-grid services. Energies, 13(9), 2231.

[6] Khamis, A. A., Khater, M. H., Abdel Aziz, A. Y., & Abdeen, M. A. (2021). Optimal operation of DC microgrid with multiple EV charging stations based on the improved particle swarm optimization algorithm. Sustainable Cities and Society, 72, 103069.

[7] Wang, Y., Lai, X., Zeng, Y., & Lai, Y. (2019). Dynamic economic operation of DC microgrid based on distributed control strategy. Energies, 12(6), 1192.

[8] Liu, C., Fan, Y., Qiu, X., & Wang, C. (2020). Optimal sizing and energy management of a DC microgrid with renewable energy and electric vehicles. Applied Energy, 266, 114944.