IJESG
e-ISSN 2636-7904
International Journal of Energy and Smart Grid
Vol 9, Number 1, 2024
Doi: 10.55088/ijesg.1598117

Review Article

A REVIEW OF ELECTRIC VEHICLES: THEIR IMPACT ON THE ELECTRICITY GRID AND ARTIFICIAL INTELLIGENCE-BASED APPROACHES FOR CHARGING LOAD MANAGEMENT

Muhammed Sefa CETIN*[1], Muhsin Tunay GENCOGLU[2], Habib SAHIN [3]

[1] Fırat University, Faculty of Engineering, Department of Electrical-Electronics Engineering, Elazığ, Türkiye
Orcid1: https://orcid.org/0000-0001-5587-0001
[2] Fırat University, Faculty of Engineering, Department of Electrical-Electronics Engineering, Elazığ, Türkiye
Orcid2: https://orcid.org/0000-0002-1774-1986
[3]Fırat University, Vocational School of Technical Sciences, Department of Electricity and Energy, Elazığ, Türkiye Orcid3: https://orcid.org/ 0000-0002-0907-2022
* Corresponding author; mscetin@firat.edu.tr

Abstract: *The widespread use of electric vehicles contributes significantly to environmental sustainability by reducing the use of fossil fuels. However, the increasing number of electric vehicles and the charging demand may cause negative impacts such as overloading, voltage fluctuations and energy supply-demand imbalances in electricity grids. In this article, artificial intelligence-based methods applied for the management of the negative impacts of electric vehicles on the grid are discussed comprehensively and artificial intelligence approaches in the literature used to manage electric vehicle charging load are analyzed. Among these approaches, energy management strategies based on charging demand forecasting, dynamic pricing, routing, charging scheduling and smart grid integration are analyzed in detail. This article summarizes the latest innovative artificial intelligence-based solutions developed to manage the charging load of electric vehicles, improve grid stability, increase charging service price prediction accuracies, maximize grid and user satisfaction, ensure load balance, reduce charging and operating costs, reduce energy consumption and optimize power flow. This article also presents comprehensive information about the bilateral (grid and user perspective) management algorithms of the charging load of electric vehicles.*

Keywords*: Electric vehicles, charging load management, electricity grid, artificial intelligence.*

Received: December 8, 2024 *Accepted: December 25, 2024*

1. Introduction

Today, global problems such as increasing carbon emissions, climate change and environmental degradation are caused by the intensive use of fossil fuels and the transportation sector accounts for a significant portion of these emissions. Internal combustion engine vehicles increase greenhouse gas emissions through road transportation, leading to global warming, decreased air quality and energy security problems. In this context, electric vehicles stand out as a powerful solution to reduce carbon emissions from transportation by operating with zero emissions, being compatible with renewable energy sources and reducing dependence on fossil fuels. The rapid development of electric vehicle technology plays an important role in achieving sustainable transportation goals [1,2].

However, with the widespread deployment of electric vehicles, some challenges also arise, especially the impacts of charging infrastructure on the electricity grid. Intensive charging demand may lead to negative impacts on the grid. Innovative approaches are currently being used to manage these issues. Electric vehicles offer an important solution to combat climate change by both reducing environmental impacts and encouraging the development of energy infrastructure [3,4]. In this article; electric vehicles are analyzed, the negative impacts of charging of electric vehicles on the grid and artificial intelligence-based methods applied to eliminate these impacts are discussed. This article contributes to the literature by offering valuable insights and important information on the use of artificial intelligence in managing the charging load of electric vehicles, providing a significant reference for researchers and readers in this field.

2. Electric Vehicles and Their Impacts

Electric vehicles stand out as an important solution for reducing carbon emissions from transportation. Unlike internal combustion engine vehicles based on fossil fuels, electric vehicles operate directly with zero emissions and reduce the amount of carbon emitted to the environment. Especially when charged with renewable energy sources, the carbon footprint of electric vehicles becomes even smaller and contributes to a sustainable transportation infrastructure. These vehicles not only improve air quality, but also increase energy security by reducing dependence on fossil fuels. The rapid development of electric vehicle technology, supported by battery efficiency, charging infrastructure and cost advantages, offers a powerful solution for mitigating the negative environmental impacts of the transportation sector [5,6].

Unlike internal combustion engines, electric vehicles use electrical energy instead of fossil fuels and therefore do not cause carbon emissions. Electric vehicles offer significant advantages such as their environmentally friendly structure, low emission rates and energy efficiency. Their utilization of electrical energy instead of fossil fuels has the potential to significantly reduce carbon emissions and air pollution. Moreover, thanks to advances in battery technologies, they also contribute to sustainable energy by preventing environmental degradation when integrated with renewable energy sources. The widespread adoption of electric vehicles will have a positive environmental impact on conserving natural resources and mitigating the effects of global warming [7]. Electric vehicles provide long-term savings for individual users with low operating and maintenance costs, while contributing to local economies by encouraging the development of charging infrastructure with innovative technologies. The widespread adoption of electric vehicles will have positive economic impacts for the vehicle sector, the energy sector and users [8].

In addition to the positive effects of the widespread use of electric vehicles, there will also be negative effects. With the widespread use of electric vehicles, problems such as overloading, voltage fluctuations and energy demand increases may occur in electricity grids, especially during peak charging demand. This situation may cause the existing grid infrastructure to be insufficient and the energy supply-demand balance to deteriorate. However, approaches such as smart grid technologies, artificial intelligence-supported energy management algorithms, energy storage systems, integration of renewable energy sources, dynamic pricing and vehicle-to-grid energy transfer (V2G) are used as solutions to manage these negative impacts on the grid [9,10].

3. Impacts of Electric Vehicle Charging on the Grid

Power quality refers to the capability of an electrical system to provide constant voltage, frequency and waveform to energy consuming devices. In cases where power quality is poor, the performance of electrical devices may be reduced and even damaged. Power quality problems in networks are usually caused by voltage fluctuations, harmonic distortions and sudden load changes. These problems both cause disruption in the energy consumption of end users and adversely affect the overall efficiency of energy systems [11].

Power quality problems are among the main technical challenges that affect the stability of energy systems and cause problems for both individual and industrial users. Among these problems, voltage fluctuations, harmonic distortions, phase shifts and deviations in the grid frequency stand out. Voltage fluctuations occur as a result of sudden addition or removal of load to the grid and may prevent the proper operation of electronic devices. Harmonic distortions are caused by nonlinear loads and cause serious distortions in the energy waveform and reduce energy efficiency. Phase shifts are imbalances between phases during energy transmission and cause synchronization problems in energy systems. In addition, the imbalance between increasing demand and supply in the grid may trigger frequency deviations and create instability in energy systems. Power quality problems may cause disruptions in energy distribution and high costs while shortening the life of devices [12-14].

The proliferation of electric vehicles may create new problems affecting power quality due to the increase in energy demand and variable load profiles. In particular, charging multiple electric vehicles at the same time may lead to voltage drops and imbalances in the grid. This causes overloading on power distribution lines, pushing the limits of the existing infrastructure. Furthermore, the non-linear nature of electric vehicle chargers increases harmonic distortion, which causes distortion of the energy waveform. Sudden energy withdrawals during the charging process may create deviations in the grid frequency and disturb the energy supply-demand balance. These effects not only undermine the stability of energy systems, but may also lead to longer charging times and increased costs for electric vehicle users. The intensive charging requirements of electric vehicles challenge the capacity of the existing grid infrastructure to manage power quality issues. Smart grid technologies and innovative energy management systems are of great importance to solve these problems effectively [15,16].

4. Managing the Impact of Electric Vehicle Charging Load on the Grid with Artificial Intelligence Based Algorithms

The proliferation of electric vehicles creates various challenges in terms of energy demand and grid stability. In order to overcome these challenges and manage the grid effectively, artificial intelligence-based algorithms have become an important solution tool in recent years. These algorithms are used in various fields such as optimizing energy consumption, ensuring load balance of charging stations, managing dynamic pricing strategies and maintaining the energy supply-demand balance effectively [17,18].

There are several advantages of performing electric vehicle charging management with artificial intelligence algorithms. These algorithms play a critical role in understanding energy consumption algorithms and impacts on the grid by analyzing large amounts of data. Variables such as charging times of electric vehicles, load density on the grid, energy prices and production levels of renewable energy sources may be analyzed in real time with artificial intelligence algorithms. These analyses enable the implementation of optimized energy management strategies to minimize imbalances on the grid [19,20].

There are many artificial intelligence-based management algorithms used to manage the effects of electric vehicle charging on the grid. Demand forecasting and load balancing forecasts energy demand and balances the load between charging stations. Charging timing optimization directs users to charge during low demand hours. Charging management based on battery status (SoC) priorities vehicles with low battery levels. V2G integration feeds energy from vehicle batteries back to the grid. Charging station layout optimization ensures stations are strategically located. Renewable energy integration plans the charging of vehicles with renewable energy sources. Multi-agent decision-making optimizes energy management by enabling cooperation between charging stations. Real-time traffic and charging status monitoring directs vehicles to the most appropriate charging stations. All of these methods are actively used. However, some of these methods are prominent in the literature. In this paper, studies on managing electric vehicle charging load with dynamic pricing, charging demand forecasting, routing, charging scheduling and smart grid strategies are analyzed.

In [21], a machine learning-based approach is developed to predict the charging behavior of electric vehicles and manage charging loads. Charging data, weather, traffic and local event information are combined to predict charging time and energy consumption. The algorithms used included Random Forest (RF), Support Vector Machine (SVM), XGBoost and Artificial Neural Networks (ANN). This article specifically aimed to improve the accuracy of charging time and energy consumption prediction and optimize the charging load. This study also aims to reduce the impacts on the grid by balancing the charging loads according to the predicted data.

In [22], an energy management system is developed to predict the charging demand of hybrid electric vehicles (HEVs) in microgrids based on renewable energy sources and to reduce the impact of this demand on the grid. HEV charging demand is estimated using Support Vector Regression (SVR) and charging scheduling is optimized based on these estimates. Charging strategies are divided into two as "coordinated charging" and "smart charging". Dragonfly Algorithm is used for optimization and the method is tested on IEEE microgrid test system. The results showed a 2.5% reduction in grid operating costs.

In [23], a two-layer deep learning model is developed to manage the charging load of electric vehicles and reduce fluctuations on the grid. The model aims to optimize pricing and charging strategies of electric vehicle users. In the first layer, charging decisions are solved by Deep Reinforcement Learning (DRL) and in the second layer, charging station selection is solved by Deep Q-Learning (DQL). The model also aims to both reduce charging costs and increase grid stability by directing charging tariffs to electric vehicle users.

In [24], a charging navigation strategy is developed to manage the charging load of electric vehicles. The strategy aims to optimize the routing of electric vehicles to charging stations taking into account empty load rates and dynamic electricity prices. With the "four networks and four flows" model, an integration between the energy network, traffic network and information network are achieved. By analyzing dynamic electricity pricing and empty load rates, the optimal charging time and station for vehicles is proposed. This method reduces the peak and trough difference on the network by providing an even distribution of charging loads.

In [25], an energy consumption model is developed to minimize the energy consumption of electric vehicles and a DRL and Transformer based network is used to optimize this model. The model takes into account vehicle dynamics, path information and charging losses when optimizing the routes of electric vehicles to reduce energy consumption. This method provides more effective results by focusing on minimizing energy consumption instead of traditional distance minimization. This article presents a solution to balance the load on the grid and manage energy consumption through the integration of charging stations and the planning of electric vehicle routes.

In [26], a Safe Reinforcement Learning (SRL) method is developed to solve the dynamic and stochastic routing problem for electric commercial vehicles. In this article, routing strategies are developed considering the uncertainties in energy consumption and customer demands. The model is formulated as a Markov Decision Process and aims to minimize energy consumption while reducing the risk of battery depletion. Through Monte Carlo simulations, dynamic customer demands and energy consumption probability distributions are estimated to plan routing and charging stops.

In [27], a deep learning framework is developed to optimize the charging times of electric vehicles and manage their load on the grid. The behavior of CopulaGAN electric vehicle charging sessions is modelled. An AutoRegressive eXogenous Neural Network (ARXNN) is used for price prediction. Grey Wolf Optimization is used for the optimization of charging and discharging times. This method aims to meet the needs of both electric vehicle users and grid operators in order to reduce charging costs and balance charging loads.

In [28], a charging scheduling method based on the Soft Actor-Critic (SAC) algorithm is developed to efficiently manage electric vehicle charging demands in a distribution network. This method aims to minimize costs and improve grid stability by effectively managing electric vehicle charging loads while considering the randomness in renewable energy generation, electricity prices, and electric vehicle charging demands.

In [29], a Twin-Delayed Deep Deterministic Policy Gradient (TDDPG) based reinforcement learning controller is developed to optimize active and reactive power control in three-phase grid-connected in-vehicle chargers to manage the impact of electric vehicle charging load on the grid. The system aims to manage grid-to-vehicle (G2V) and V2G bidirectional power flows. This improves the stability of the grid while ensuring precise tracking of active and reactive power references. This article presents a smart energy management platform to manage the charging loads of electric vehicles and mitigate their impact on the grid.

In [30], a Multi-Agent Reinforcement Learning (MARL) method is developed to manage the charging load of electric vehicles and balance their energy demands on the grid. The proposed method is based on a centralized training and decentralized execution framework to simultaneously optimize energy purchasing strategies and energy distribution strategies. Electric vehicle flow is predicted by a Long Short-Term Memory (LSTM)-based neural network, while energy purchasing strategies are determined by the Multi-Agent Deep Deterministic Policy Gradient (MADDPG) method. Furthermore, an online heuristic routing (OHD) method is proposed for energy distribution.

In [31], a machine learning-based system is proposed to manage the charging load of electric vehicles while considering the impacts on the distribution grid. The system integrates conventional charging, fast charging, and V2G technologies to optimize grid performance. Charging station routing and speed selection are performed using LSTM networks, which successfully minimize load variance, power losses, and voltage fluctuations. Additionally, user charging costs are reduced by leveraging V2G technology, allowing energy feedback to the grid during peak hours. Various machine learning algorithms, including Decision Trees (DT), RF, SVM, K-Nearest Neighbors (KNN) and Deep Neural Networks (DNN) are evaluated with LSTM emerging as the most accurate and robust method. The proposed system provides a reliable, data-driven solution for grid stability and user satisfaction by optimizing energy distribution and reducing overload risks.

Artificial intelligence-based approaches are becoming increasingly important in energy management to mitigate the adverse effects of electric vehicles on electricity grid. As demonstrated in various studies [21-31], these methods offer innovative solutions in fields such as balancing charging loads, optimizing pricing strategies and enhancing grid integration. In addressing issues like load intensity and grid instability during electric vehicle charging processes, artificial intelligence-supported algorithms facilitate decision-making processes and deliver valuable outcomes for both users and grid operators. This article emphasizes the opportunities presented by artificial intelligence in the development of charging load management strategies, providing a significant contribution to the creation of more flexible and sustainable solutions in the future.

Table 1. Studies in the literature.

Reference	**Management Strategy**	**AI Method**	**Aims**	**Application Field**
[21]	Charging demand	RF, SVM, XGBoost, ANN	Balancing charging loads, improve forecasting accuracy	Charging stations
[22]	Charging demand	SVR	Ensure grid load balance, reduce operating costs	Microgrid (Renewable energy and HEV integration)
[23]	Pricing and routing	DRL, DQL	Enhance grid stability, lower charging costs	Charging stations and users
[24]	Pricing and routing	Dynamic pricing, Graph theory	Balancing charging loads, reduce traffic congestion	Traffic and grid integration
[25]	Routing	Transformer based DRL	Enhance grid stability, reduce energy consumption	Vehicle routing
[26]	Routing	SRL	Enhance grid reliability, reduce energy consumption	Vehicle routing
[27]	Scheduling	CopulaGAN, ARXNN	Ensure grid balance, lower charging costs	Parking lots
[28]	Scheduling	SAC	Enhance grid stability, reduce costs	Distribution network
[29]	Smart Grid	Twin-Delayed DDPG	Improve grid stability, optimise power flow	Smart grid (V2G and G2V integration)
[30]	Smart Grid	MARL (MADDPG, LSTM)	Ensure grid balance, enhance user satisfaction	Smart grid (Charging station network)
[31]	V2G	LSTM, DT, RF, SVM, KNN, DNN	Flattening the load curve, reducing power losses, minimizing voltage fluctuations	Charging stations and distribution grids

5. Conclusions

The widespread adoption of electric vehicles is recognized as an important step towards reducing carbon emissions in the transportation sector and eliminating fossil fuel dependency. However, the intense charging demand created by this transformation on the energy infrastructure may lead to problems that threaten grid stability. To mitigate the negative impacts of electric vehicles on the grid and to optimize energy management, artificial intelligence-based solutions are becoming prominent. This paper provides a comprehensive review of artificial intelligence approaches for electric vehicle charging management. Methods such as charging demand forecasting, dynamic pricing, charging scheduling and smart grid integration stand out as effective algorithms to balance charging loads, optimize costs and increase grid stability. Artificial intelligence-based solutions have demonstrated significant success in effectively managing the charging load of electric vehicles, enhancing grid stability, and optimizing energy costs.

In the future, integrating these methods with renewable energy sources and supporting them with energy storage technologies will provide higher efficiency and flexibility in energy management. In addition, multiple systems and hybrid artificial intelligence models that enable real-time management of all components on the grid stand out as promising areas for both academic research and industrial applications. In conclusion, the adaptation of artificial intelligence-based methods is a critical strategy to manage the impacts of electric vehicles on energy infrastructure and the grid and to create a more sustainable transportation system. Future studies should focus on the broader applications and applicability of these methods.

Ethical statement

Ethics Committee approval is not required.

Conflict of interest

The authors declare no conflict of interest.

Authors' Contributions

M. S. C: Conceptualization, Writing - Original draft preparation, Formal analysis (%40).
M. T. G: Methodology, Resources, Investigation (%30).
H. S: Conceptualization, Methodology, Writing - Original draft preparation, Investigation (%30).
All authors read and approved the final manuscript.

References

[1] Tian, X., Zha, H., Tian, Z., Lang, G., Li, L., "Carbon emission reduction capability assessment based on synergistic optimization control of electric vehicle V2G and multiple types power supply", *Energy Reports*, 11, 1191-1198, 2024.

[2] Qadir, S. A., Ahmad, F., Al-Wahedi, A. M. A., Iqbal, A., Ali, A., "Navigating the complex realities of electric vehicle adoption: A comprehensive study of government strategies, policies, and incentives", *Energy Strategy Reviews*, 53, 101379, 2024.

[3] Çetin, M. S., Gençoğlu, M. T., Dobrzycki, A., "Investigation of Charging Technologies for Electric Vehicles", *Turkish Journal of Science and Technology*, 19(1), 97-106, 2024.

[4] Williams, B., Bishop, D., Hooper, G., Chase, J. G., "Driving change: Electric vehicle charging behavior and peak loading", *Renewable and Sustainable Energy Reviews*, 189, 113953, 2024.

[5] Zhao, X., Hu, H., Yuan, H., Chu, X., "How does adoption of electric vehicles reduce carbon emissions? Evidence from China", *Heliyon*, 9(9), 2023.

[6] Guo, X., Sun, Y., Ren, D., "Life cycle carbon emission and cost-effectiveness analysis of electric vehicles in China", *Energy for Sustainable Development*, 72, 1-10, 2023.

[7] Albrechtowicz, P., "Electric vehicle impact on the environment in terms of the electric energy source—Case study", *Energy Reports*, 9, 3813-3821, 2023.

[8] Rapson, D. S., Muehlegger, E., "The economics of electric vehicles", *Review of Environmental Economics and Policy*, 17(2), 274-294, 2023.

[9] Khalid, M. R., Khan, I. A., Hameed, S., Asghar, M. S. J., Ro, J., "A comprehensive review on structural topologies, power levels, energy storage systems, and standards for electric vehicle charging stations and their impacts on grid", *IEEE Access*, 9, 128069-128094, 2021.

[10] Şengör, İ., Çiçek, A., Erenoğlu, A. K., Erdinç, O., Catalão, J. P., "User-comfort oriented optimal bidding strategy of an electric vehicle aggregator in day-ahead and reserve markets", *International Journal of Electrical Power & Energy Systems*, 122, 106194, 2020.

[11] Dobrzycki, A., Kasprzyk, L., Çetin, M. S., Gençoğlu, M. T., "Analysis of the Influence of the Charging Process of an Electrical Vehicle on Voltage Distortions in the Electrical Installation", *Applied Sciences*, 14(17), 7691, 2024.

[12] Nour, M., Chaves-Ávila, J. P., Magdy, G., Sánchez-Miralles, Á., "Review of positive and negative impacts of electric vehicles charging on electric power systems", *Energies*, 13(18), 4675, 2020.

[13] Rahman, S., Khan, I. A., Khan, A. A., Mallik, A., Nadeem, M. F., "Comprehensive review & impact analysis of integrating projected electric vehicle charging load to the existing low voltage distribution system", *Renewable and Sustainable Energy Reviews*, 153, 111756, 2022.

[14] Dobrzycki, A., Çetin, M. S., Gençoğlu, M. T., "Harmonics generated during the electric vehicle charging process", 2. International Conference on Advances and Innovations in Engineering (ICAIE), Elazığ, Türkiye, pp. 173-178, 2023.

[15] Tavakoli, A., Saha, S., Arif, M. T., Haque, M. E., Mendis, N., Oo, A. M., "Impacts of grid integration of solar PV and electric vehicle on grid stability, power quality and energy economics: A review", *IET Energy Systems Integration*, 2(3), 243-260, 2020.

[16] Wang, L., Qin, Z., Slangen, T., Bauer, P., Van Wijk, T., "Grid impact of electric vehicle fast charging stations: Trends, standards, issues and mitigation measures—An overview", *IEEE Open Journal of Power Electronics*, 2, 56-74, 2021.

[17] Abdullah, H. M., Gastli, A., Ben-Brahim, L., "Reinforcement learning based EV charging management systems–a review", *IEEE Access*, 9, 41506-41531, 2021.

[18] Zhang, X., Chan, K. W., Li, H., Wang, H., Qiu, J., Wang, G., "Deep-learning-based probabilistic forecasting of electric vehicle charging load with a novel queuing model", *IEEE Transactions on Cybernetics*, 51(6), 3157-3170, 2020.

[19] Dabbaghjamanesh, M., Moeini, A., Kavousi-Fard, A., "Reinforcement learning-based load forecasting of electric vehicle charging station using Q-learning technique", *IEEE Transactions on Industrial Informatics*, 17(6), 4229-4237, 2020.

[20] Shern, S. J., Sarker, M. T., Ramasamy, G., Thiagarajah, S. P., Al Farid, F., Suganthi, S. T., “Artificial Intelligence-Based Electric Vehicle Smart Charging System in Malaysia”, *World Electric Vehicle Journal*, 15(10), 440, 2024.

[21] Shahriar, S., Al-Ali, A. R., Osman, A. H., Dhou, S., Nijim, M., “Prediction of EV charging behavior using machine learning”, *IEEE Access*, 9, 111576-111586, 2021.

[22] Lan, T., Jermsittiparsert, K., Alrashood, S. T., Rezaei, M., Al-Ghussain, L., Mohamed, M. A., “An advanced machine learning based energy management of renewable microgrids considering hybrid electric vehicles’ charging demand”, *Energies*, 14(3), 569, 2021.

[23] Lin, H., Zhou, Y., Li, Y., Zheng, H., “Aggregator pricing and electric vehicles charging strategy based on a two-layer deep learning model”, *Electric Power Systems Research*, 227, 109971, 2024.

[24] Zhong, J., Liu, J., Zhang, X., “Charging navigation strategy for electric vehicles considering empty-loading ratio and dynamic electricity price”, *Sustainable Energy, Grids and Networks*, 34, 100987, 2023.

[25] Tang, M., Zhuang, W., Li, B., Liu, H., Song, Z., Yin, G., “Energy-optimal routing for electric vehicles using deep reinforcement learning with transformer”, *Applied Energy*, 350, 121711, 2023.

[26] Basso, R., Kulcsár, B., Sanchez-Diaz, I., Qu, X., “Dynamic stochastic electric vehicle routing with safe reinforcement learning”, *Transportation Research Part E: Logistics and Transportation Review*, 157, 102496, 2022.

[27] Gharibi, M. A., Nafisi, H., Askarian-Abyaneh, H., Hajizadeh, A., “Deep learning framework for day-ahead optimal charging scheduling of electric vehicles in parking lot”, *Applied Energy*, 349, 121614, 2023.

[28] Jin, J., Xu, Y., “Optimal policy characterization enhanced actor-critic approach for electric vehicle charging scheduling in a power distribution network”, *IEEE Transactions on Smart Grid*, 12(2), 1416-1428, 2020.

[29] Ahmadian, A., Sedghisigarchi, K., Gadh, R., “Empowering dynamic active and reactive power control: A deep reinforcement learning controller for three-phase grid-connected electric vehicles”, *IEEE Access*, 2024.

[30] Zhang, Y., Yang, Q., An, D., Li, D., Wu, Z., “Multistep multiagent reinforcement learning for optimal energy schedule strategy of charging stations in smart grid”, *IEEE Transactions on Cybernetics*, 53(7), 4292-4305, 2022.

[31] Shibl, M., Ismail, L., Massoud, A., “Electric vehicles charging management using machine learning considering fast charging and vehicle-to-grid operation”, *Energies*, 14(19), 6199, 2021.