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Optimizing Sustainable Urban Mobility: Integration Of Electric Vehicle Charging Infrastructure Into Smart Buildings

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Abstract
The integration of electric vehicle (EV) charging infrastructure into smart buildings is a crucial step toward enhancing sustainable urban mobility. This paper explores the benefits, challenges, strategies, and best practices associated with this integration, with a focus on optimizing EV charging accessibility and promoting a cleaner transportation ecosystem. Traditional vehicles powered by fossil fuels contribute significantly to pollution and greenhouse gas emissions, highlighting the urgent need for sustainable alternatives. EVs offer reduced emissions, lower operating costs, and potential energy independence through renewable sources, making them a promising solution for urban mobility challenges. Despite these advantages, the widespread adoption of EVs faces hurdles, particularly regarding charging infrastructure availability and accessibility in urban areas. Range anxiety among EV users due to insufficient charging stations is a significant concern hindering the transition to electric transportation. The paper emphasizes strategic placement of charging stations, integration with renewable energy sources like solar panels, and utilization of smart grid technologies to optimize EV charging operations. Case studies such as Tesla Gigafactory Shanghai and Googleplex showcase successful implementations, demonstrating scalability, user-centric design, and seamless integration with building management systems. Key challenges such as funding constraints, technical interoperability, and grid integration are addressed, proposing solutions like innovative financing models, standardization efforts, and advanced grid management technologies. By addressing these challenges and implementing sustainable solutions, the integration of EV charging infrastructure into smart buildings can significantly contribute to reducing environmental impact, promoting cleaner transportation options, and fostering a more sustainable and resilient urban environment.
Keywords: *Charging Infrastructure, Electric Vehicles (EVs), Renewable Energy, Smart Buildings, Sustainable Urban Mobility*

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I. Introduction

Background and Context: The rapid urbanization and increasing environmental concerns have placed significant pressure on transportation systems worldwide. Traditional vehicles powered by fossil fuels contribute significantly to pollution and greenhouse gas emissions, exacerbating environmental degradation and public health issues. In response to these challenges, the adoption of electric vehicles (EVs) has gained momentum as a promising solution for sustainable urban mobility. EVs offer reduced emissions, lower operating costs, and potential energy independence through renewable energy sources.

Despite the benefits of EVs, their widespread adoption faces hurdles, particularly in urban areas. One of the critical challenges is the availability and accessibility of adequate EV charging infrastructure. Urban environments often lack sufficient charging stations, leading to range anxiety among EV users and hindering the transition to electric transportation. This gap in infrastructure highlights the need for strategic planning and innovative solutions to optimize EV charging accessibility and support the growth of sustainable mobility options.

Importance and Significance: Integrating EV charging infrastructure into smart buildings presents a transformative opportunity to address the challenges of EV adoption in urban environments. Smart buildings leverage advanced technologies such as IoT (Internet of Things), data analytics, and automation to optimize energy usage, enhance user experience, and improve overall efficiency. By integrating EV charging capabilities into smart buildings, synergies can be created to promote sustainable transportation and energy management.

The significance of this integration extends beyond individual buildings to the broader urban landscape. It aligns with the goals of smart cities, where interconnected systems and data-driven decision-making promote sustainability, resilience, and quality of life. Efficient EV charging infrastructure in smart buildings can reduce strain on the electrical grid, promote renewable energy integration, and contribute to a cleaner urban environment.

Thesis Statement and Research Objectives: This research aims to explore strategies for the seamless integration of EV charging infrastructure with smart building technology to enhance sustainability and efficiency in urban transportation. The thesis statement encapsulates the core focus of the study, which is to investigate how the integration of EV charging infrastructure into smart buildings can optimize urban mobility and contribute to a more sustainable transportation ecosystem.

The research objectives are outlined as follows:

1. Investigate the potential benefits of integrating EV charging infrastructure into smart buildings for optimizing urban mobility.
2. Identify the key challenges and opportunities associated with this integration.
3. Explore strategies and best practices for effectively implementing and managing integrated EV charging infrastructure within the context of smart buildings.
4. Examine case studies and real-world examples to illustrate successful implementations and lessons learned.

These objectives guide the research process, and contributing to knowledge in the field of sustainable urban mobility and smart infrastructure integration.

II. Overview Of Electric Vehicle Charging Infrastructure

Types of EV Charging Stations: Electric vehicle charging infrastructure encompasses various types of charging stations designed to meet different charging needs. Level 1 chargers are typically used for residential charging and operate on a standard 120-volt outlet, providing a slow charging rate suitable for overnight charging. Level 2 chargers, often installed in homes and public charging stations, utilize a 240-volt power source and offer faster charging speeds compared to Level 1 chargers. These chargers are suitable for daily charging needs and can fully charge an EV in a few hours. On the other hand, DC fast chargers, also known as Level 3 chargers, provide rapid charging capabilities by delivering direct current (DC) power to the vehicle's battery. These chargers are commonly found along highways and in commercial areas, offering quick charging sessions that can significantly reduce charging times compared to Level 1 and Level 2 chargers.

Current Challenges and Limitations: Despite the advancements in EV charging infrastructure, several challenges and limitations persist. One significant challenge is the need for widespread availability and accessibility of charging stations, particularly in urban areas and along major transportation routes. Range anxiety, or the fear of running out of charge before reaching a charging station, remains a concern for EV drivers, highlighting the importance of expanding charging infrastructure to alleviate these concerns. Interoperability and standardization of charging protocols are also areas of focus, as EV manufacturers and charging network providers work towards common standards to ensure compatibility and ease of use for consumers. Additionally, managing peak demand on the electrical grid during high-usage periods presents technical challenges that require smart grid solutions and load management strategies to optimize charging without overloading the grid.

Importance of Strategic Placement: Strategic placement of EV charging infrastructure plays a crucial role in promoting EV adoption and supporting sustainable urban mobility. Strategic placement involves identifying high-traffic areas, key transportation corridors, and locations with high EV concentrations to deploy charging stations effectively. By strategically placing charging stations in residential areas, workplaces, retail centers, and public facilities, EV drivers gain convenient access to charging while going about their daily routines. Moreover, integrating charging infrastructure into smart buildings and parking facilities enhances accessibility and encourages EV adoption by offering seamless charging experiences. Strategic placement also considers factors such as proximity to amenities, visibility, safety, and ease of use to create a user-friendly charging network. This approach not only addresses range anxiety but also promotes EV usage for various purposes, including commuting, business travel, and leisure activities. Furthermore, strategic placement supports the overall goal of reducing carbon emissions, improving air quality, and transitioning towards a more sustainable transportation ecosystem.

III. Strategies For Optimizing EV Charging Infrastructure In Smart Buildings

Charging Station Types and Configurations

Optimizing EV charging infrastructure within smart buildings involves selecting appropriate charging station types and configurations to address the diverse needs of users. Level 2 AC chargers are commonly deployed due to their moderate charging speed (7-11 kW) and compatibility with most EV models Mousavi (2021). These chargers can be wall-mounted or pedestal-mounted in parking areas, providing convenient access for EV owners. Fast-charging options, such as DC fast chargers (50 kW or higher), may also be strategically placed in high-traffic areas within or near smart buildings to cater to quick-charging requirements of EV users with longer commutes. Configurations may vary based on factors such as building size, anticipated EV demand, available electrical capacity, and user preferences. This necessitates a flexible and scalable approach to charging infrastructure design Mousavi (2021).

Integration with Building Management Systems

Effective integration of EV charging infrastructure with building management systems (BMS) enhances energy efficiency, load management, and user experience. BMS can monitor and control energy consumption across the entire building, allowing smart buildings to optimize EV charging schedules based on electricity demand and pricing dynamics Hao (2019). Integration with BMS enables features such as demand response, where EV charging can be coordinated to align with off-peak electricity periods, reducing overall energy costs and grid stress. Furthermore, BMS integration facilitates data analytics and predictive maintenance for EV chargers, ensuring optimal performance and reliability while minimizing downtime. Seamless communication between EV charging systems and BMS fosters a synergistic relationship that maximizes energy efficiency and sustainability within smart building environments.

Utilization of Renewable Energy Sources

The integration of renewable energy sources, such as solar photovoltaic (PV) panels, with EV charging infrastructure in smart buildings contributes to sustainability and reduces carbon footprint. Liu (2020). Solar PV systems installed on building rooftops or adjacent parking structures can generate clean energy to power EV charging stations, reducing reliance on grid electricity and promoting self-sufficiency. Energy management systems can intelligently prioritize solar energy utilization for EV charging during daylight hours, aligning with peak solar generation periods and reducing overall electricity costs Hu (2021). Additionally, surplus solar energy can be stored in onsite battery storage systems or fed back into the grid, enhancing grid stability and resilience. The utilization of renewable energy sources not only reduces environmental impact but also aligns with sustainable practices and green building initiatives within smart building ecosystems.

Incorporation of Smart Grid Technologies

Smart grid technologies play a vital role in optimizing EV charging infrastructure within smart buildings. These technologies enable dynamic load management, demand response, and grid balancing capabilities to enhance overall system efficiency and reliability.

Vehicle-to-Grid (V2G) technologies allow bidirectional energy flow between EVs and the grid, enabling EVs to serve as distributed energy storage units during peak demand periods or grid emergencies Yang (2020). This bidirectional capability not only supports grid stability but also offers potential revenue streams for building owners or EV fleet operators through participation in energy markets or ancillary services.

Smart grid integration also facilitates data exchange between EVs, charging infrastructure, and utility providers, enabling real-time monitoring, billing, and optimization of EV charging operations. By incorporating smart grid technologies, smart buildings can leverage advanced energy management strategies to maximize renewable energy utilization, minimize energy costs, and contribute to a more resilient and sustainable energy infrastructure.

IV. Literature Review

The inadequate availability of charging infrastructure remains a primary barrier to widespread adoption of electric vehicles, as highlighted by Joshi (2021). This scarcity contributes to consumer anxiety regarding battery depletion and its consequences, with convenience and speed often prioritized over environmental concerns in transportation choices. To address this challenge, the literature emphasizes the development of a universal charging station utilizing public electricity grids and solar panels. This approach aims to enhance accessibility and reliability in charging electric vehicles, supported by controlled power delivery mechanisms and IoT-based secure interfaces for customers, as described by Joshi (2021). By leveraging solar energy as a sustainable and eco-friendly power source, this solution aligns with the imperative to mitigate global warming and transition towards renewable energy-based transportation systems, ultimately contributing to net-zero emissions and environmental preservation at scale.

The Automatic Electric Vehicle Charging station developed by Pakhare. (2024) represents an advanced solution for autonomous power supply units in electric vehicle charging. It operates independently without human attendants and integrates smoothly with existing power grid infrastructure. Using a Raspberry Pi as the primary controller and an LCD Display for the User Interface, the system offers AC level 1, 2, or DC level 3 charging options and communicates with Electric Vehicle Battery Management Systems for safety checks and negotiation of charging parameters. Safety features like a 30A relay circuit and emergency switches ensure controlled access and user safety. Real-time payments through RazorPay enhance user convenience, while monitoring capabilities display charge status and remaining time. The system's adherence to level 3 AC charging SAE standards reflects its commitment to safety and quality in electric vehicle charging infrastructure.

As the adoption of electric vehicles (EVs) continues to rise due to their benefits like low fuel economy and reduced emissions, the need for efficient charging infrastructure has become crucial. Fixed electric vehicle charging stations (EVCSs) have gained popularity for providing charging services, but selecting the right station can be challenging given the varying charging requirements of different EVs. In response to this challenge, Devi. (2023) propose an optimal charging station selection scheme based on the technique for order performance by similarity to ideal solution (TOPSIS). This scheme evaluates EVCSs based on multiple criteria and assigns a performance score, allowing EVs to book charging slots at the highest-ranked stations. The authors conduct an analysis of this scheme using 10 EVCSs and 3 EVs to demonstrate its effectiveness in ensuring appropriate and efficient charging services for EV users.

This paper introduces an innovative solar-powered electric vehicle (EV) charging station design that tackles key issues of fuel consumption and environmental pollution. As electric cars gain global acceptance for their environmental advantages and economic viability, this proposed charging system presents a distinctive solution by enabling wireless charging while vehicles are in motion, eliminating the need for stops. The system operates entirely on solar energy, eliminating dependence on external power sources. The report details the engineering and design of a solar-powered EV charger integrated into roads, offering an efficient solution to the challenges of fuel consumption and emissions. This advancement aligns with the expanding use of electric vehicles worldwide and their positive impact on reducing transportation costs by replacing costly fuels with affordable electricity. By allowing vehicles to charge on the go, this infrastructure contributes to more efficient and environmentally friendly electric vehicle charging. Taksande, (2024)

Renewable energy has emerged as a critical resource in the twenty-first century, driven by concerns over excessive oil consumption. This shift has spurred the development of technologies centered around renewable energy sources like solar, wind, wave, and geothermal power. Concurrently, the automotive sector has witnessed a surge in Electric Vehicle (EV) production, necessitating the establishment of charging infrastructure. In this context, Alagumariappan (2023) introduce a novel charging station design leveraging solar energy as its primary source. The station's key feature is its DC–DC converter, which harnesses energy from photovoltaic (PV) arrays. Furthermore, the charging station employs the YOLO v3 model for vehicle detection and battery charging. Notably, the station's ability to share battery energy information with other charging stations enhances its utility and scalability within the EV charging ecosystem.

In a study by Olcay (2023) the growing impact of electric vehicle charging stations on electricity networks worldwide was investigated. They analyze the negative effects of these stations on grid stability and propose solutions to mitigate these impacts. Using an installed charging station in a suitable area as their case study, they measure and examine its energy consumption using an energy analyzer. A detailed electrical network model is created using the Electrical Transient Analyzer Program (ETAP) and validated with IEEE 6-bus power test system data. The study simulates the addition of loads from multiple charging stations to the network, revealing significant increases in power losses. To address these challenges, the study proposes the integration of grid-connected solar power plants (SPP) to reduce power losses and enhance grid stability. The results demonstrate a notable decrease in network losses after incorporating solar power plants, highlighting the potential of renewable energy solutions to mitigate the negative impacts of electric vehicle charging station loads on electricity networks.

In their exploration of transportation's future, Çetin et al. (2024) delve into the transition from internal combustion engine vehicles to electric vehicles (EVs) as a means of addressing harmful emissions associated with fossil fuel usage. EVs, powered by electric motors and battery packs, offer a clean and zero-emission alternative. The study emphasizes the potential environmental benefits when EV charging stations are powered by renewable energy sources. Rechargeable Lithium-ion battery packs, coupled with fast charging technology, support the practicality of EVs. The paper also delves into the standards and technologies underpinning EV charging stations, highlighting advancements in MATLAB/Simscape-based EV system design, contributing to the sustainable evolution of transportation infrastructure.

In their comprehensive review, Hakam (2024) provides a detailed analysis of electric vehicles (EVs), encompassing various aspects ranging from vehicle categories to charging methodologies, while addressing emerging challenges and future prospects. The article examines fundamental EV categories and charging methods, emphasizing their pivotal role in smart electrical grids (SEG) and exploring advanced technologies like wireless power transfer and communication protocols. It also delves into EV battery (EVB) chargers, categorizing them by power capacity and direction of power flow, with a focus on Level 1, Level 2, and Level 3 chargers. Emerging charging technologies and their impact on transportation electrification are discussed, along with design considerations for DC fast charging stations and strategies for integrating them into charging infrastructures. The review also introduces vehicle-to-grid (V2G) communications and future electrification scenarios, including compensation of reactive power and technologies like V4G (vehicle-for-grid). Additionally, the paper elaborates on the Model Predictive Control (MPC) algorithm, exploring its application in fast chargers through artificial intelligence techniques, providing insights into future developments in EV charging technology.

A study by Meng (2024) delve into the complexities surrounding the management of electric vehicle (EV) charging stations as they expand rapidly. These challenges arise from uncertainties in EV usage patterns, pricing strategies at charging stations, and their integration with distribution networks. To tackle these issues, a two-stage energy management framework is proposed. Initially, a resource allocation model is developed to consider the profitability of distribution systems, charging stations, and EV users. This model relies on the aggregate feasible power regions of charging stations, derived through a combination of Minkowski summation and a data-driven approach aimed at safeguarding EV data privacy and minimizing computational loads. The second stage introduces an innovative hierarchical pricing mechanism that incorporates clearing prices between charging stations and distribution networks, along with retail electricity prices between charging stations and EV users. Charging stations engage in power clearing activities with distributed networks based on the aggregate feasible power region, while a two-stage robust pricing strategy is established between EV users and charging stations. The model undergoes optimization through a distributed coordination mechanism that offers clear physical interpretations. Simulation results demonstrate the efficacy of the proposed aggregation method, showcasing improvements in charging stations' economic profits compared to alternative methods. Moreover, the hierarchical pricing mechanism leads to enhanced total economic profits for charging stations and reduced operating costs for distributed networks.

Electric Vehicle (EV) chargers, also known as Electric Vehicle Supply Equipment (EVSE), play a crucial role in providing electrical power for charging plug-in electric vehicles. While batteries require Direct Current (DC) power for charging, most electric vehicles are equipped with onboard Alternating Current (AC) to DC converters, allowing them to accept both AC and DC power inputs. The widespread adoption of EVs holds the potential to alleviate noise and environmental pollution, especially when coupled with electricity generated from renewable sources (Gulzar et al., 2024). DC charging stations with multiple ports and levels are common, catering to various EV models. EVSEs are located in diverse settings such as street-side locations, retail centers, and government facilities, facilitating convenient charging for EV users. Promoting EV usage and establishing Electric Vehicle Charging Stations (EVCS) is pivotal for reducing carbon emissions and promoting sustainable transportation, including in the context of tourism. The authors of this study have mapped EVSEs across Indian states and union territories, enabling EV users to easily locate charging stations and plan their journeys. This effort not only benefits current EV owners but also encourages broader adoption of EVs, contributing to environmental sustainability efforts.

In their study, Li et al. (2023) explore the integration of electric vehicles (EVs) in the cold chain logistics sector to enhance energy efficiency and environmental sustainability. They propose an optimization model for EV routing in cold chain logistics with charging stations, aiming to minimize overall logistics costs while considering various cost components and dynamic factors such as time-varying speed, electricity prices, energy consumption, and queuing at charging stations. The study introduces a hybrid crow search algorithm (CSA) that combines opposition-based learning (OBL) and taboo search (TS) for optimization purposes. Their experiments demonstrate the effectiveness of the hybrid CSA compared to other algorithms like genetic algorithm (GA) and particle swarm optimization (PSO). The research contributes to sustainable logistics planning by providing a comprehensive model that considers real-world complexities in EV routing for cold chain logistics.

In their systematic review, Saputra et al. (2023) thoroughly analyzes the technical aspects of robotic charging for Electric Vehicles (EVs), aiming to identify research trends, methods, and challenges. The study implements a Systematic Literature Review (SLR) methodology, covering articles from 2012 to 2022 and utilizing key databases such as Web of Science, Scopus, Dimensions, and Lens. The review encompasses autonomous docking, charging socket detection, pose estimation, plug insertion, and robot manipulator design aspects. Key challenges identified include robustness in socket pose estimation and plug insertion, with insights into sensor technologies and control approaches to improve success rates and efficiency. This review provides valuable insights into the evolving landscape of robotic charging for EVs, contributing to advancements in this critical area of research.

V. Case Studies And Future Directions

Successful Implementations and Case Studies:

1. **Tesla Gigafactory Shanghai:** Tesla's Gigafactory in Shanghai serves as a notable case study in integrating EV charging infrastructure into a smart industrial complex. The facility incorporates a comprehensive EV charging network, including Level 2 chargers for employees and DC fast chargers for visitors and fleets. The integration with Tesla's energy management system optimizes charging schedules and grid interactions, showcasing a scalable model for large-scale EV adoption within industrial settings (Tesla, 2021).
2. **Googleplex Charging Infrastructure:** Google's headquarters, known as Googleplex, features an extensive EV charging infrastructure integrated into its smart parking facilities. The deployment of smart charging stations, coupled with real-time availability updates through mobile apps, enhances user convenience and promotes EV adoption among employees and visitors. Google's approach emphasizes user experience, sustainability, and seamless integration with smart building technologies (Google, 2020).
3. **Urban Redevelopment Projects:** Several urban redevelopment projects, such as the Hudson Yards development in New York City and the Docklands redevelopment in London, incorporate EV charging infrastructure as part of their smart city initiatives. These projects demonstrate the integration of EV charging stations into public spaces, commercial complexes, and residential areas, fostering sustainable transportation options and contributing to city-wide EV adoption goals (NYCEDC, 2021; TFL, 2022).
4. **Electric Vehicle Fleets in Smart Cities:** Municipalities and private companies operating electric vehicle fleets showcase successful implementations of centralized charging hubs and smart fleet management systems. Case studies from cities like Oslo, Norway, and Amsterdam, Netherlands, highlight the efficiency gains and emission reductions achieved through optimized charging, route planning, and fleet utilization strategies (Oslo Municipality, 2020; Amsterdam Smart City, 2021).

Analysis of Best Practices and Lessons Learned: Analyzing these case studies reveals several best practices and lessons learned in optimizing EV charging infrastructure within smart buildings and urban environments. Key practices include:

i. Scalability and flexibility in charging infrastructure design to accommodate diverse user needs and future EV market growth.
ii. Integration with energy management systems and smart grids for demand response, load balancing, and renewable energy utilization.
iii. User-centric design, accessibility, and seamless integration with smart building amenities to enhance user experience and encourage EV adoption.
iv. Collaboration among stakeholders, including building developers, utilities, EV manufacturers, and government agencies, to address regulatory, technical, and financial challenges.

Lessons learned from successful implementations emphasize the importance of proactive planning, data-driven decision-making, ongoing monitoring, and continuous optimization of EV charging infrastructure to maximize efficiency, reliability, and sustainability.

Challenges, Barriers, and Potential Solutions: Despite the progress in EV charging infrastructure integration, several challenges and barriers persist. These include:

i. Cost implications and funding constraints for deploying and maintaining extensive charging networks, especially in retrofitting existing buildings or infrastructure.
ii. Technical interoperability challenges among EV charging standards, software platforms, and building management systems, requiring standardized protocols and compatibility testing.
iii. Grid integration challenges, such as managing peak demand, grid congestion, and local distribution system upgrades to support increased EV charging loads.

Potential solutions to these challenges include:

i. Innovative financing models, public-private partnerships, and incentives to accelerate EV infrastructure deployment and reduce upfront costs for building owners and operators.
ii. Development and adoption of open standards and interoperable protocols for EV charging, data exchange, and grid integration to enhance system flexibility and scalability.
iii. Advanced grid management technologies, such as demand forecasting, dynamic pricing, and smart grid infrastructure upgrades, to optimize EV charging operations and mitigate grid impacts.

Addressing these challenges and implementing sustainable solutions is crucial for scaling up EV charging infrastructure in smart buildings and urban environments, paving the way for widespread

References

[1] Joshi, A., Somaiya, K. M. V., Hariram, A. T., & Hussain, M. Z. (2021). Electric Vehicle Charging Station. International Journal Of Scientific Research In Science, Engineering And Technology, 122–128. Https://Doi.Org/10.32628/Ijsrset218429
[2] Pakhare, S.R., Baig, R., Athani, A., & Mhade, S., (2024). Automatic Electric Vehicle Charging Station. Scholars Journal Of Engineering And Technology, 12(01), 1-18
[3] Devi, N. N., Panda, G., & Thokchom, S. (2023). Optimal Ranking-Based Charging Station Selection For Electric Vehicles. International Journal Of Emerging Electric Power Systems, 0(0). Https://Doi.Org/10.1515/Ijeeps-2023-0124
[4] Alagumariappan, P., Vijayalakshmi, S., Swamynathan, K., Mahalingam, N., & Gughan, N. M. (2023). Innovative Smart Network Enabled Charging Station For Future Electric Vehicle. Journal Of Institution Of Engineers (India) Series B. Https://Doi.Org/10.1007/S40031-023-00961-5
[5] Olcay, K., & Çetinkaya, N. (2023). Investigation Of The Effects Of Electric Vehicle Charging Stations And Solar Energy Integration On Grid Performance. Journal Of Scientific Reports-A :, 055, 206–219. Https://Doi.Org/10.59313/Jsr-A.1397996
[6] Çetin, M. S., Gençoğlu, M. T., & Dobrzycki, A. (2024). Investigation Of Charging Technologies For Electric Vehicles. Turkish Journal Of Science And Technology. Https://Doi.Org/10.55525/Tjst.1399120
[7] Hakam, Y., Gaga, A., & Elhadadi, B. (2024). Exploring The State Of Electric Vehicles: An Evidence-Based Examination Of Current And Future Electric Vehicle Technologies And Smart Charging Stations. Energy Reports, 11, 4102–4114. Https://Doi.Org/10.1016/J.Egyr.2024.04.002
[8] Gulzar, Y., Dutta, M., Gupta, D., Juneja, S., Soomro, A. B., & Mir, M. S. (2024). Revolutionizing Mobility: A Comprehensive Review Of Electric Vehicles Charging Stations In India. Frontiers In Sustainable Cities, 6. Https://Doi.Org/10.3389/Frsc.2024.1346731
[9] Li, Y., Lim, M. K., Xiong, W., Yun, L., Shi, Y., & Wang, S. (2023). An Electric Vehicle Routing Model With Charging Stations Consideration For Sustainable Logistics. Industrial Management + Data Systems/Industrial Management & Data Systems, 124(3), 1076–1106. Https://Doi.Org/10.1108/Imds-08-2023-0581
[10] Saputra, H. M., Nor, N. S. M., Rijanto, E., Zain, M., Darus, I. Z. M., & Yazid, E. (2023). A Review Of Robotic Charging For Electric Vehicles. International Journal Of Intelligent Robotics And Applications. Https://Doi.Org/10.1007/S41315-023-00306-X
[11] Mousavi, S. M., Aminifar, E., & Seyed-Hosseini, S. M. (2021). A Comprehensive Review On Energy Management Of Plug-In Hybrid Electric Vehicles In Smart Grids. Renewable And Sustainable Energy Reviews, 140, 110780. Doi: Doi.Org/10.1016/J.Rser.2021.110780
[12] Hao, S., Cheng, M., Wang, J., & Zhang, Y. (2019). Optimal Scheduling Of Charging And Discharging For Electric Vehicles In Smart Grids. Ieee Transactions On Smart Grid, 10(3), 3201-3211. Doi: Doi.Org/10.1109/Tsg.2018.2870884
[13] Yang, H., Xu, Z., Li, W., & Wang, X. (2020). V2g Aggregator's Optimal Decision-Making For Joint Energy And Ancillary Services Markets Considering User Preferences. Applied Energy, 269, 115102. Doi: Doi.Org/10.1016/J.Apenergy.2020.115102
[14] Liu, X., Guo, S., Zuo, W., & Wang, Y. (2020). Photovoltaic-Powered Electric Vehicle Charging Stations: A Review Of Technical Challenges And Economic Benefits. Journal Of Power Sources, 478, 126232. Doi: Doi.Org/10.1016/J.Jpowsour.2020.126232
[15] Hu, J., Wu, Q., Wei, Z., Xu, J., & Zhang, X. (2021). Optimal Scheduling Of Electric Vehicle Charging With Photovoltaic Power Generation Considering User Preferences And Time-Varying Electricity Prices. Energy, 239, 122243. Doi: Doi.Org/10.1016/J.Energy.2021.122243
[16] K, D. (2024). Wireless Electric Vehicle Charging With Solar Panels. Indian Scientific Journal Of Research In Engineering And Management, 08(04), 1–5. Https://Doi.Org/10.55041/Ijsrem30237