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A COMPREHENSIVE REVIEW ON ELECTRIC VEHICLE INTERFACING TECHNIQUES AND CHARGING INFRASTRUCTURE FOR ACTIVE DISTRIBUTION NETWORKS

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ABSTRACT

The accelerating adoption of electric vehicles (EVs) and the global shift toward sustainable transportation demand efficient integration of EV charging infrastructure within active distribution networks (ADNs). This paper presents a focused review of EV interfacing techniques, charging standards, and grid-supporting technologies essential for reliable and optimized power system operation. The study outlines the evolution of EV technologies and compares major charging configurations—Type-1, Type-2, and Type-3 highlighting their functional characteristics, power levels, communication requirements, and implications on grid stability. Special emphasis is placed on solar photovoltaic (PV)–based EV charging systems, which offer significant benefits in reducing grid dependence, lowering operational costs, and enhancing environmental sustainability. Additionally, the paper examines bidirectional charging and Vehicle-to-Grid (V2G) concepts, describing their role in peak load management, ancillary service support, and distributed energy storage utilization. Key technical challenges such as voltage fluctuations, harmonic distortion, feeder congestion, interoperability issues, and battery degradation are critically analyzed. The review also identifies emerging trends, including smart charging controls, AI-based scheduling, and advanced power electronic interfaces, which can enable efficient EV integration. Overall, this paper provides a consolidated perspective for researchers and practitioners aiming to enhance EV–grid interaction within future intelligent distribution networks.

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1. INTRODUCTION

The global transportation sector is undergoing a major transition driven by environmental concerns, technological advancements, and policy initiatives promoting the shift toward clean mobility. Electric vehicles (EVs) have gained significant attention as a key solution for reducing greenhouse gas emissions and dependence on fossil fuels [1], supported by rapid advancements in battery technologies, reduction in battery costs, and increased charging infrastructure development [2]. As countries accelerate EV adoption to meet sustainable energy targets and climate commitments, the loading on electrical grids is projected to rise substantially, especially at the distribution level where most EV charging occurs [3], [4]. Although EVs offer environmental benefits and operational efficiency, their widespread deployment introduces major technical challenges for existing power distribution systems that were primarily designed for predictable and unidirectional power flow [5]. This emerging dependency on electrical power for transportation creates the motivation for a detailed review of EV interfacing techniques within active distribution networks (ADNs) [6].

Integrating large numbers of EVs into ADNs is challenging due to the stochastic and concentrated nature of charging demand. Peak charging periods, typically aligned with residential load peaks, can lead to transformer overloading, voltage instability, line congestion, and accelerated equipment aging [7], [8]. Uncontrolled charging, when numerous vehicles connect simultaneously without coordination, exacerbates these issues by introducing sudden load spikes that degrade grid reliability and power quality [9]. Moreover, the increasing diversity in EV charging levels—ranging from slow AC charging (3.3–7.4 kW) to fast and ultra-fast DC charging (50–350 kW)—creates varying stresses on distribution feeders [10]. The absence of unified charging communication standards and inconsistency in safety protocols across charging types further complicates EV integration into the grid [11]. Therefore, standardization of EV charging systems and effective interfacing mechanisms are crucial to ensure secure, reliable, and efficient operation of modern distribution networks.

In the context of ADNs, which already accommodate distributed energy resources (DERs) such as rooftop solar PV, battery storage, and smart inverters, EVs present both challenges and opportunities [12]. EVs, equipped with advanced power electronic converters, can function not only as electrical loads but also as distributed energy storage units capable of providing ancillary grid services [13]. Technologies such as Vehicle-to-Grid (V2G), Vehicle-to-Home (V2H), and Vehicle-to-Building (V2B) enable bidirectional power flow, allowing EVs to contribute to demand response, frequency regulation, and voltage support [14], [15]. Solar PV–based EV charging stations are emerging as a promising option to reduce dependency on the grid and support renewable energy utilization, especially in regions with high solar irradiation [16]. Despite these advantages, the deployment of V2G and renewable-assisted charging systems faces obstacles including interoperability concerns, battery degradation, communication delays, insufficient economic incentives, and cybersecurity threats [17]. These limitations indicate the need for a deeper understanding of EV interfacing technologies and their operational implications in active distribution systems.

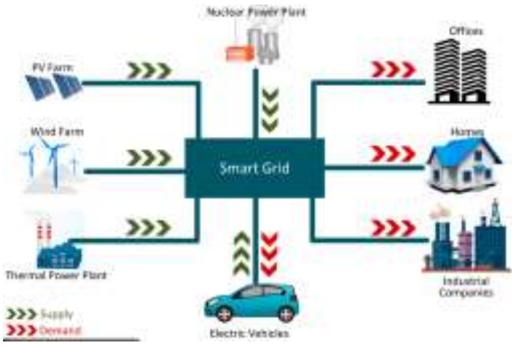


Fig 1. Overview of the system

A critical evaluation of literature reveals persistent gaps in understanding the comprehensive impact of EV integration on distribution grid stability, protection schemes, and power quality [18]. Many studies focus narrowly on aspects such as battery characteristics, EV charging behavior, or renewable energy integration, lacking a holistic consideration of how EVs interact dynamically with ADNs. Issues such as harmonic distortion due to power electronic converters, reverse power flow during V2G operation, and the combined influence of distributed PV and EV charging have received limited systematic analysis [19]. Moreover, the lack of coordinated control strategies and real-time energy management frameworks for large-scale EV deployment represents a major research gap that must be addressed to ensure future scalability [20]. These gaps justify the need for a concise and focused review that synthesizes EV charging technologies, interfacing methods, and grid integration challenges.

Given these demands, this paper presents a comprehensive review of EV interfacing techniques and charging infrastructures with respect to their impact on active distribution networks. The review addresses key aspects such as charging standardization, power electronic interfacing, smart charging methodologies, renewable-assisted charging architectures, and the role of V2G in supporting grid stability. By consolidating findings from recent research and identifying open challenges, this paper aims to provide a clear and organized knowledge base for researchers, system planners, and policymakers. The insights derived from this work contribute to the development of intelligent, flexible, and sustainable EV–grid integration strategies that enable reliable operation of future distribution networks.

II. OVERVIEW OF EV TECHNOLOGIES

Electric vehicles (EVs) represent a transformative evolution in modern transportation, offering clean mobility solutions designed to reduce emissions, minimize energy consumption, and promote greater sustainability across the global automotive landscape. Their growing presence in both urban and rural transportation systems has sparked extensive research into the underlying technologies that enable efficient, safe, and flexible operation. To understand the integration of EVs within active distribution networks, it is essential first to analyze the classifications, power sources, charging technologies, and powertrain interfacing mechanisms that form the core architecture of modern electric vehicles.

EVs are primarily classified into three major categories — Battery Electric Vehicles (BEVs), Plug-in Hybrid Electric Vehicles (PHEVs), and Fuel Cell Electric Vehicles (FCEVs). BEVs operate exclusively on electric power stored in onboard battery packs and require external charging infrastructure. Their simplicity, zero tailpipe emissions, and high energy efficiency make them a leading solution for sustainable mobility. PHEVs combine an internal combustion engine with a battery-driven electric motor, enabling both electrical and fuel-powered operation. These vehicles offer extended driving ranges while reducing overall emissions. FCEVs, on the other hand, utilize hydrogen fuel cells to generate electricity through electrochemical reactions. Although less common due to cost and infrastructure limitations, FCEVs provide long range and fast refueling, making them suitable for heavy-duty or long-distance applications.

The power sources in EVs primarily consist of high-capacity rechargeable batteries. Lithium-ion (Li-ion) batteries dominate the industry due to their superior energy density, long cycle life, and relatively low weight. Variants such as NMC (Nickel-Manganese-Cobalt) and LFP (Lithium Iron Phosphate) offer optimized performance for different use cases — NMC for high-performance vehicles and LFP for budget-friendly models. Other chemistries such as solid-state batteries are emerging, promising higher safety and greater energy density but are still under development. Power is delivered from the battery to the motor via sophisticated power electronics, including inverters and control units.

Charging systems play a crucial role in EV functionality. On-board chargers (OBCs) handle AC-to-DC conversion when plugged into standard AC charging stations. Typical OBC capacities range from 3.3 kW to 22 kW depending on the vehicle and charging standard. DC fast charging bypasses the OBC by supplying regulated DC power directly to the battery, enabling significantly reduced charging times. Charger types differ in connector design, safety protocols, and communication systems, but all are centered around ensuring efficient and safe energy transfer.

Understanding powertrain interfacing basics is essential for analyzing EV-grid integration. An EV powertrain typically includes the battery pack, battery management system (BMS), DC/DC converter, inverter, electric motor, and drivetrain. The BMS monitors state of charge (SOC), thermal conditions, and battery health, ensuring stable and safe operation. The DC/DC converter manages voltage levels between components, while the inverter converts DC battery power into AC for motor operation. The motor, usually an induction motor or permanent magnet synchronous motor (PMSM), converts electrical energy into mechanical torque.

The charger interface within the powertrain includes communication modules that exchange data with the charger and sometimes with the grid operator. These modules support protocols such as CHAdeMO, CCS, and IEC standards, enabling functions such as charging authorization, power control, and vehicle-to-grid (V2G) interactions. Smart interfacing is increasingly important as EVs evolve into active components within distribution networks, capable of providing support services like reactive power compensation and frequency regulation.

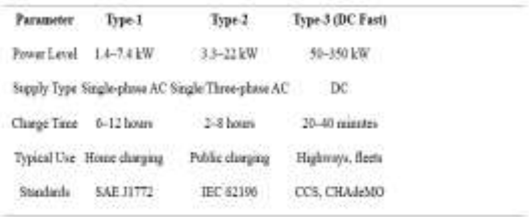
In summary, the technological foundation of EVs—including their classification, battery systems, charging technologies, and powertrain architecture—plays a critical role in determining how effectively they can integrate with large-scale distribution networks. This understanding provides the basis for analyzing charging infrastructure, grid impacts, and advanced EV-based renewable integrations discussed in subsequent sections.

III CHARGING INFRASTRUCTURE AND STANDARDS

Charging infrastructure is a key enabler for widespread adoption of electric vehicles, making it essential to evaluate the technical characteristics, standards, and associated grid impacts of different charging types. As EV penetration increases globally, distribution networks must accommodate various charging levels that differ significantly in power rating, charging duration, connector design, and communication protocols. These differences influence not only charging efficiency but also the overall stability and reliability of the power system.

The primary classification of EV charging is based on power levels and connection types: Type-1, Type-2, and Type-3 charging. Type-1 charging, common in North America and Japan, uses a single-phase AC connection, typically operating between 1.4 kW and 7.4 kW. It is suitable for domestic charging and provides slower charging speeds, requiring several hours for a full charge. Type-2 charging, widely used in Europe and Asia, supports both single-phase and three-phase AC connections, enabling power delivery between 3.3 kW and 22 kW. Its higher efficiency and flexibility make it ideal for public charging stations. Type-3 or DC fast charging systems supply high-power DC directly to the battery, bypassing the on-board charger. Power levels range from 50 kW to 350 kW, drastically reducing charging time to as little as 20–40 minutes depending on battery capacity and charger rating.

Table 1: Comparison of Type-1, Type-2, Type-3 Chargers



Parameter	Type-1	Type-2	Type-3 (DC Fast)
Power Level	1.4–7.4 kW	3.3–22 kW	50–350 kW
Supply Type	Single-phase AC	Single/Three-phase AC	DC
Charge Time	6–12 hours	2–8 hours	20–40 minutes
Typical Use	Home charging	Public charging	Highways, fleets
Standards	SAE J1772	IEC 62196	CCS, CHAdeMO

The distinction between AC and DC charging is crucial. AC chargers rely on the vehicle’s on-board charger to rectify AC into DC before charging the battery, limiting charging speed to the OBC's capacity. DC chargers incorporate external rectifiers, enabling higher charging currents and faster charging cycles. Standards such as IEC 61851, IEC 62196, SAE J1772, CCS (Combined Charging System), and CHAdeMO define connector designs, safety requirements, and communication protocols. These standards ensure safe energy transfer and interoperability between EVs and charging stations.

Large-scale deployment of charging stations introduces considerable stress on distribution networks. High-power chargers particularly create localized peak loads that can exceed transformer capacities, leading to overheating, aging, and premature failure. Voltage drops along feeders become more pronounced when multiple EVs charge simultaneously, especially during residential evening peak hours. Uncoordinated charging increases power losses, contributes to power quality issues such as harmonic distortion due to power electronic converters, and may necessitate costly infrastructure reinforcement.

These impacts highlight the importance of smart charging coordination using demand response techniques, time-of-use tariffs, and predictive algorithms to prevent network overloading. As EV penetration grows, understanding the performance and limitations of charging infrastructures becomes essential for planning resilient and future-ready distribution systems.

IV SOLAR PV–BASED EV CHARGING SYSTEMS

Solar photovoltaic (PV)–based EV charging systems represent a sustainable and increasingly popular solution that reduces grid dependence, lowers operational costs, and supports the global transition to renewable energy. By harnessing solar energy for EV charging, these systems provide clean electricity, decrease carbon footprints, and offer long-term economic benefits. As EV adoption continues to escalate, integrating solar PV into charging infrastructure is seen as an effective method of balancing energy demand and minimizing peak load stress on distribution networks.

The architecture of a solar PV–based EV charging station typically includes a PV array, DC/DC converter, inverter, charge controller, and sometimes a battery storage system. The PV array captures solar irradiance and converts it into DC electrical power. A DC/DC converter optimizes the operating point via maximum power point tracking (MPPT) to ensure that the PV modules operate with maximum efficiency under varying sunlight conditions. The inverter converts DC power into AC when interfacing with the grid or AC chargers. The charge controller manages energy flow between the PV source, battery storage (if present), and EV charger, ensuring safe and balanced power delivery.

A major advantage of solar-powered EV charging is its ability to reduce dependency on grid electricity, especially during peak hours. This not only improves grid stability but also reduces electricity bills for consumers and operating costs for charging station providers. Since EVs effectively shift transportation energy consumption from fossil fuels to renewable sources, solar PV charging significantly lowers CO_2 emissions and supports climate objectives. Additionally, combining solar PV with local energy storage allows charging stations to operate even in areas with limited grid availability, making them suitable for remote or developing regions.

Despite its benefits, solar PV–based EV charging faces several technical challenges. Solar energy is inherently intermittent due to varying weather conditions, causing fluctuations in power output. Effective energy storage or hybrid grid-PV systems are required to maintain consistent charging capability. MPPT controllers must be efficient and responsive to extract peak power under rapidly changing irradiance conditions. System sizing is another important concern; oversized systems incur unnecessary cost, while undersized systems limit charging capability. Integrating bidirectional inverters for V2G compatibility adds further complexity.

Overall, solar PV–integrated EV charging stations offer a promising pathway toward sustainable and resilient energy systems. Their ability to support clean mobility while alleviating grid burden makes them a strong candidate for future EV infrastructure development.

V EV INTERFACING WITH ACTIVE DISTRIBUTION NETWORKS

Integrating electric vehicles into active distribution networks (ADNs) is a critical challenge in modern power systems as charging demand continues to increase. ADNs differ from traditional distribution networks by incorporating distributed generation, intelligent monitoring, and active control strategies. The interaction of EVs with such networks depends significantly on how charging is managed, the nature of connected chargers, and the power electronics used to regulate power flow. The interfacing mechanisms between EVs and ADNs determine the overall impact on power quality, grid reliability, and system stability.

Uncontrolled charging, also known as conventional plug-in charging, occurs when EV users connect their vehicles to the grid without coordination. Charging typically begins immediately and continues until the battery reaches full capacity. While this approach is simple and user-friendly, it produces heavy load spikes during peak demand periods—especially in residential neighborhoods where EV users tend to charge in the evening. Such simultaneous high-power demand can lead to transformer overloading, severe voltage drops, excessive line currents, and accelerated equipment aging. Uncontrolled charging also reduces the feeder’s load diversity, creating high load concentration that compromises network reliability.

Smart charging, in contrast, uses coordinated charging algorithms, communication between EVs and grid operators, and real-time energy management to control when and how EVs draw power from the grid. Smart charging shifts EV demand to off-peak periods, applies charging rate control based on grid conditions, and incorporates time-of-use pricing to incentivize optimal charging behavior. Advanced smart charging infrastructure enables techniques such as demand response, valley filling, peak shaving, and optimal scheduling. By flattening load curves and enhancing system flexibility, smart charging significantly improves grid resilience while reducing operational stress on transformers and feeders.

Power quality and stability issues represent another critical area of concern when integrating EVs into ADNs. EV chargers use power electronic converters that generate harmonic distortion, leading to additional losses, heating of equipment, and potential malfunction of sensitive devices. High concentrations of EV chargers along the same feeder can increase total harmonic distortion beyond acceptable limits, violating power quality standards. Voltage imbalance may occur when multiple single-phase chargers are connected across phases unevenly. Reverse power flow, especially under Vehicle-to-Grid (V2G) operation or when combined with local distributed generation such as rooftop solar, further complicates protection schemes and voltage regulation. Sudden changes in charging or discharging rates can create transient fluctuations, affecting both voltage and frequency stability. These factors highlight the need for adaptive voltage control, harmonic mitigation techniques, and enhanced grid monitoring systems.

Power electronic interfaces act as the bridge between EVs and distribution networks, enabling efficient and controlled energy transfer. AC chargers typically use on-board power electronic converters within the vehicle to perform AC–DC rectification, limiting charging speed to the capacity of the on-board charger. DC fast chargers use off-board converters that provide high-power DC directly to the battery, enabling faster charging while shifting the conversion burden to the charging station. Power electronic converters also support bidirectional operation, enabling both charging and discharging. Bidirectional converters include DC/DC stages for battery interface and DC/AC stages to interact with the grid. These converters support functionalities such as reactive power compensation, harmonic filtering, and grid support under V2G mode. Advanced converters integrate grid-forming and grid-following controls to enhance stability in high renewable penetration environments.

Overall, the interfacing of EVs with ADNs requires effective charging coordination, power quality enhancement, and robust power electronic systems. As EV penetration increases, the role of intelligent control, bidirectional conversion, and system-wide communication becomes crucial for ensuring that distribution networks remain stable, efficient, and capable of supporting future electrified transportation demands.

VI VEHICLE-TO-GRID (V2G) AND BIDIRECTIONAL CHARGING

Vehicle-to-Grid (V2G) technology represents one of the most transformative innovations in electric mobility, enabling EVs to operate not only as electrical loads but also as distributed energy storage resources. Through bidirectional charging, EVs can supply power back to the grid during peak demand periods or provide ancillary services such as voltage regulation, frequency support, and spinning reserves. V2G systems rely on sophisticated power electronic interfaces, communication protocols, and grid coordination strategies to ensure seamless exchange of energy between EVs and distribution networks.

The fundamental concept of V2G involves enabling EVs to charge from the grid when energy is abundant and inexpensive, and discharge back to the grid when electricity demand is high. Variants of this concept include Vehicle-to-Home (V2H), which allows EVs to power residential loads; Vehicle-to-Building (V2B), which supports commercial facilities; and Vehicle-to-Load (V2L), which enables the EV to supply power to standalone devices or loads during off-grid operation. V2G functionality depends on bidirectional chargers integrated with communication systems based on standards such as ISO 15118, facilitating energy management, power dispatch, authentication, and billing processes.

The benefits of V2G for distribution systems are substantial. One of the most notable advantages is peak shaving, where EVs discharge power during peak load hours to alleviate stress on transformers, feeders, and substations. This reduces the need for infrastructure upgrades and enhances system reliability. Frequency regulation is another key benefit; since EV batteries can respond rapidly to grid frequency fluctuations, they can help stabilize the system by injecting or absorbing power as required. Reactive power support is also possible with advanced bidirectional converters, enabling EVs to enhance power factor, maintain voltage profiles, and reduce line losses. In systems with high renewable penetration, EVs can mitigate intermittency and supply-demand imbalance by acting as distributed storage units that smooth fluctuations in solar or wind generation.

Despite the advantages, V2G deployment faces significant challenges. Battery degradation is a primary concern, as frequent charge-discharge cycles can shorten battery life. However, modern battery management strategies and optimized V2G control algorithms aim to limit degradation by maintaining operation within safe limits. Communication standards present another challenge, as seamless interoperability across different manufacturers and charging infrastructures requires harmonized protocols, secure data exchange, and low-latency communication. Cybersecurity is an increasingly critical issue since V2G systems connect millions of mobile energy storage devices to the grid, creating potential entry points for cyberattacks. Economic feasibility poses further challenges because cost-benefit outcomes depend on local energy prices, incentives, and market structures.

Despite these challenges, advancements in bidirectional power converters, predictive control algorithms, and communication standards are accelerating the adoption of V2G systems. With proper support from utilities and policymakers, V2G can become a vital component of future smart grids. The integration of renewable energy sources, distributed generation, and intelligent charging infrastructure makes V2G an essential technology for enhancing system flexibility, resilience, and sustainability.

VII Research Gaps & Future Directions

Research Gaps

- Lack of unified global charging and communication standards
- Insufficient real-time implementation of V2G systems

- High battery degradation concerns under frequent cycling
- Limited harmonic mitigation strategies in EV-dense networks
- Underdeveloped power quality models for mixed PV–EV systems

Future Directions

- AI-based optimal charging coordination and predictive scheduling
- Hybrid solar PV + energy storage + V2G charging hubs
- Integration of blockchain for secure energy transactions
- Microgrid-enabled EV clusters for local energy balancing
- Advanced bidirectional converters with grid-forming capabilities

CONCLUSION

The integration of electric vehicles into active distribution networks is reshaping the operational dynamics of modern power systems. As EV adoption increases, effective interfacing mechanisms—ranging from smart charging to advanced power electronic converters—are essential to maintain grid stability and reliability. V2G and solar-based charging systems offer promising pathways for enhancing energy flexibility, reducing peak loads, and supporting renewable integration. However, achieving these benefits requires standardized communication protocols, optimized charging strategies, and intelligent control systems capable of responding to real-time grid conditions. Overall, EV–grid coordination supported by smart energy management and bidirectional power flow technologies will play a decisive role in building resilient, sustainable, and future-ready power distribution networks.

REFERENCES

[1] A. Mohammad, R. Zamora, and T. T. Lie, "Integration of Electric Vehicles in the Distribution Network: A Review of PV Based Electric Vehicle Modelling," *Energies*, vol. 13, no. 17, p. 4541, 2020. (MDPI)

[2] F. Ahmed *et al.*, "A holistic review of electric vehicle charging impacts on power distribution networks: Technical challenges, smart mitigation strategies and future directions," *Applied Energy*, vol. 402, pt. B, art. 126961, 2026. (ScienceDirect)

[3] A. Tayri and X. Ma, "Grid Impacts of Electric Vehicle Charging: A Review of Challenges and Mitigation Strategies," *Energies*, vol. 18, no. 14, p. 3807, 2025. (MDPI)

[4] J. Ru, M. Gillott, and R. Shipman, "Vehicle-to-Grid (V2G) Research: A Decade of Progress, Achievements, and Future Directions," *Energies*, vol. 18, no. 23, p. 6148, 2025. (MDPI)

[5] E. Mogire, P. Kilbourn, and R. Luke, "Smart Charging for E-Mobility in Urban Areas: A Bibliometric Review," *Energies*, vol. 18, no. 17, p. 4655, 2025. (MDPI)

[6] J. S. Tamba II, A. Abdulkarim, and A. N. Shuaibu, "Solar powered electric vehicle charging system: a comprehensive review," *Discover Electronics*, vol. 2, art. 96, 2025. (SpringerLink)

[7] A. Shafiq *et al.*, "Solar PV-Based Electric Vehicle Charging Station for Security Bikes: A Techno-Economic and Environmental Analysis," *Sustainability*, vol. 14, no. 21, p. 13767, 2022. (MDPI)

[8] A. Srivastava *et al.*, "Electric vehicle integration's impacts on power quality in distribution network and associated mitigation measures: a review," *Journal of Engineering and Applied Science*, 2023. (SpringerLink)

[9] M. Kumar, K. P. Panda, R. T. Naayagi, R. Thakur, and G. Panda, "Comprehensive review of electric vehicle technology and its impacts: detailed investigation of charging infrastructure, power management, and control techniques," *Applied Sciences*, vol. 13, p. 8919, 2023. (SpringerLink)

[10] E. Goldin, L. E. Erickson, B. Natarajan, A. Pahwa, and L. E. Erickson, "Solar powered charge stations for electric vehicles," *Environmental Progress & Sustainable Energy*, 2013. (SpringerLink)

[11] M. P. Kazmierkowski, "Solar powered charging infrastructure for electrical vehicles:

a sustainable development," *IEEE Industrial Electronics Magazine*, vol. 11, no. 2, pp. 72–73, 2017. (SpringerLink)

[12] S. Ray *et al.*, "Impact of EV charging on electrical distribution network and mitigating solutions – A review," (review article on distribution network hosting capacity and mitigation), 2023. (ResearchGate)

[13] A. Mohammad *et al.*, "Integration of Electric Vehicles in the Distribution Network: A Review of PV Based Electric Vehicle Modelling," (EV–PV interaction, smart charging and uncertainty modelling), *Energies*, 2020. (MDPI)

[14] S. A. Tayri and X. Ma, "Grid Impacts of Electric Vehicle Charging: A Review of Challenges and Mitigation Strategies," (hosting capacity, voltage, congestion and mitigation), *Energies*, 2025. (MDPI)

[15] S. Vadi, R. Bayindir, A. M. Colak, and E. Hossain, "A review on communication standards and charging topologies of V2G and V2H operation strategies," *Energies*, vol. 12, p. 3748, 2019. (MDPI)

[16] Z. U. Zahid *et al.*, "Design of Bidirectional DC–DC Resonant Converter for Vehicle-to-Grid (V2G) Applications," *IEEE Transactions on Transportation Electrification*, vol. 1, pp. 232–244, 2015. (MDPI)

[17] A. Triviño, J. M. Gonzalez-Gonzalez, and M. Castilla, "Review on Control Techniques for EV Bidirectional Wireless Chargers," *Electronics*, vol. 10, p. 1905, 2021. (MDPI)

[18] B. K. Sovacool, J. Kester, L. Noel, and G. Z. de Rubens, "The Future Promise of Vehicle-to-Grid (V2G) Integration: A Sociotechnical Review and Research Agenda," *Annual Review of Environment and Resources*, vol. 42, pp. 377–406, 2017. (MDPI)

[19] T. Yuvaraj, K. R. Devabalaji, J. A. Kumar, S. B. Thanikanti, and N. I. Nwulu, "A comprehensive review and analysis of the allocation of electric vehicle charging stations in distribution networks," *IEEE Access*, vol. 12, pp. 5404–5461, 2024. (MDPI)

[20] P. Pradhan, I. Ahmad, M. H. Habibi, G. Kothapalli, and M. A. S. Masoum, "Reducing the impacts of electric vehicle charging on power distribution transformers," *IEEE Access*, vol. 8, pp. 210183–210193, 2020. (MDPI)