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Electric Vehicle Integration with Energy Sources: Problem and Solution Review

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Abstract: Vehicle-to-Grid (V2G) integration with energy sources is an interface solution for power and environmental problems. However, some of the face limitations during the integration as overloading, power losses, and voltage sag are furtherly discussed in this article. The Renewable Energy Sources (RESs) are the promising solution by overcoming the power challenges during integration with Electric Vehicles (EVs) in on-grid or off-grid systems. This article is discussing the RESs integrated with EV along with the charging locations, RESs types, challenges faced in the grid with V2G integration, and appliances load types.

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1. Introduction

The integration of Renewable Energy Sources (RESs) with Electric Vehicles (EVs) can provide great advantages such as reducing Green Hous Gas (GHG) emissions and satisfying load demand. The classification of energy sources integrated into utility grid through sub-station in order to power the end-users EVs in two energy charging systems residential and commercial as shown in Figure 1 [1].

The main contribution of the article is to provide a comprehensive review of the V2G integration problems. This mini-review article is categorized as follows: Section 1 Introduction, Section 2 denoted for RESs integration classifications. Section 3 referred to the issues and expected solutions for charging EVs. Eventually, the conclusion flowed by the references is placed in the last section.

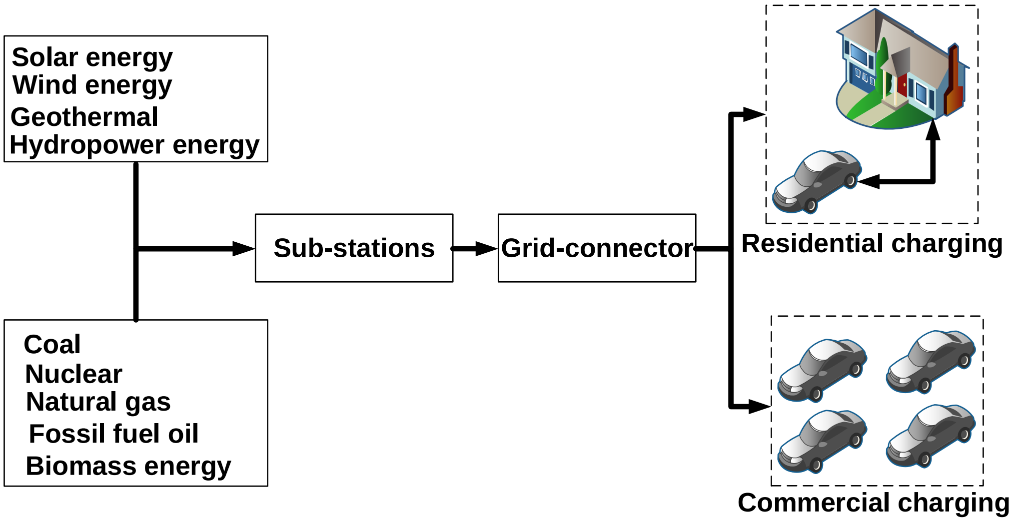

Figure 1 Residential and commercial charging diagram.

2. Classification of RESs integration

Generally, electrical energy can be defined as the flow of electric charge that resulted from a force to reach an object. In an electrical system, various types of energy can be used to run electric appliances such as EVs where the energy sources can be divided into two types. Renewable and non-renewable energy sources as listed below with their partial explanation.

2.1 Renewable

They are naturally found sources such as Wind Energy (WE), Photovoltaic (PV), Fuel cell (FC), geothermal, and hydropower energy. The aforesaid RESs are a promising solution in contrary to non-renewable energy sources in order to achieve the goal of Sustainable and Development Goal 7 (SDG7) Affordable and Clean Energy.

2.2 Non-renewable

The different forms of non-renewable sources are fossil fuel (coal-natural gas-oil), nuclear, and biomass energy are used to power the electrical systems and are mostly available. Nevertheless, the aforementioned sources are providing power and environmental pollutions.

3. Issues and proposed solutions

There are several locations EVs can be charged as presented in the state-of-the-art such as residential [2]–[5], university [6], [7], shopping [8], workplace [9], military [10], [11]. Figure 2 demonstrates the different charging locations that can be used to charge EVs.

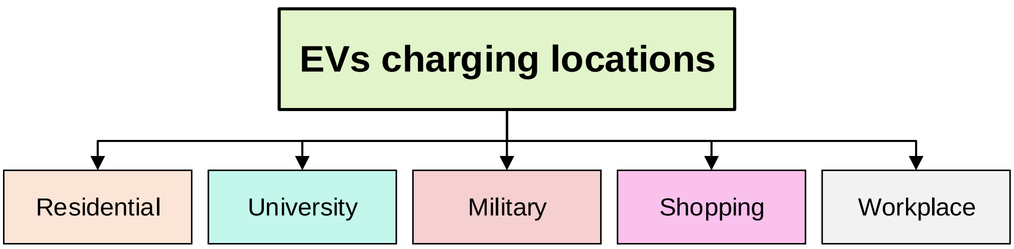

Figure 2 Different EVs charging/discharging locations.

Some of the listed problems while integrating EV into the grid as tabulated in Table 1 [12]. If the charging has been unwell, scheduling the system will face overcurrent and under-voltage problems in the EVs. The effect of the aforementioned issue is the high power at a specific peak load [13].

Table 1 Grid Faced challenges with electric vehicles.

Problem Type	Effects	Expected solution
Overloading	• Reducing lifespan of a transformer • Transformer failure	Time Scheduling charging
Voltage instability	• Low voltage in the power system • Power outage and damaging home appliances	Using power conversions
Excessive harmonic injection	• Effects on EVs chargers by generating harmonics • Poor Power quality	Using power conversions
Power losses	• Massive power losses • Voltage deviation	Coordinating EV charging with a fewer number of EVs
Voltage dip/sag	• Decreasing in charging controls • Voltage dip limitation.	Using Charging control
Voltage imbalance	• Poor power quality affects the power phasing system (three-phase only).	Nature-inspired algorithms
Frequency variation	• Frequency variation caused by penetration of EVs and unwell coordinated charging • Damaging the electrical system	Coordinate EV charging

In terms of working hours, there are three different types of loads as hard and soft loads. Where the former means utilizing home electric appliances for all time as a refrigerator that can be classified as type A (hard) [14]. While the latter is partially exploiting the load with utilizing some load for a limited time can be called type B (soft), at the same time, EVs can be classified under type C due to the long hours charging EV more than type B.

Conclusion

In this article, the two charging locations as residential and commercial charging stations are discussed along with the integration sources. The faced challenges in charging areas with the expected solution were discussed. Different types of loads as A (hard), B (soft), and C (soft) were partially discussed with their electrical appliances.

Aknwlodegment

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References

[1] A. Hashmi and M. T. Gul, "Integrating E-vehicle into the power system by the execution of vehicle-to-grid (V2G) terminology — A review," in *2018 International Conference on Engineering and Emerging Technologies (ICEET)*, Feb. 2018, vol. 2018-Janua, pp. 1–5, doi: 10.1109/ICEET1.2018.8338642.

[2] J. Van Roy, N. Leemput, F. Geth, R. Salenbien, J. Buscher, and J. Driesen, "Apartment Building Electricity System Impact of Operational Electric Vehicle Charging Strategies," *IEEE Trans. Sustain. Energy*, vol. 5, no. 1, pp. 264–272, Jan. 2014, doi: 10.1109/TSTE.2013.2281463.

[3] H. Turker and S. Bacha, "Smart Charging of Plug-in Electric Vehicles (PEVs) in Residential Areas: Vehicle-to-Home (V2H) and Vehicle-to-Grid (V2G) concepts," *Int. J. Renew. Energy Res.*, vol. 4, no. 4, pp. 859–871, 2014, doi: 10.20508/ijrer.25419.

[4] H. Turker, M. Hauck, A. Hably, and S. Bacha, "A tool of Vehicle-to-Grid (V2G) concept for voltage plan control of residential electric grid areas with Plug-in Hybrid Electric Vehicles (PHEVs)," in *IECON 2012 - 38th Annual Conference on IEEE Industrial Electronics Society*, Oct. 2012, pp. 2883–2888, doi: 10.1109/IECON.2012.6389437.

[5] A. Alsharif, C. W. Tan, R. Ayop, K. Y. Lau, and A. M. Dobi, "A rule-based power management strategy for Vehicle-to-Grid system using antlion sizing optimization," *J. Energy Storage*, vol. 41, no. July, p. 102913, Sep. 2021, doi: 10.1016/j.est.2021.102913.

[6] K. Anoune, M. Bouya, A. Astito, and A. Ben Abdellah, "Design and sizing of a Hybrid PV-Wind-Grid System for Electric Vehicle Charging Platform," *MATEC Web Conf.*, vol. 200, p. 00008, Sep. 2018, doi: 10.1051/matecconf/201820000008.

[7] A. R. Bhatti and Z. Salam, "Photovoltaic (PV) Charging of Electric Vehicle (EV)," *Electr. Eng. Res. Colloq. Electron. Power, Instrum. Control Commun.*, vol. 1, no. April, pp. 102–103, 2013.

[8] S. Singh, P. Chauhan, and N. J. Singh, "Feasibility of Grid-connected Solar-wind Hybrid System with Electric Vehicle Charging Station," *J. Mod. Power Syst. Clean Energy*, vol. 9, no. 2, pp. 295–306, 2021, doi: 10.35833/MPCE.2019.000081.

[9] G. R. R. Chandra Mouli, P. Bauer, and M. Zeman, "System design for a solar powered electric vehicle charging station for workplaces," *Appl. Energy*, vol. 168, no. 2016, pp. 434–443, Apr. 2016, doi: 10.1016/j.apenergy.2016.01.110.

[10] S. B. S. B. C. N. U. Pakdeetrakulwong, "Investigating Electric Vehicle (EV) Charging Station Locations for Agartala , India," in *2nd International Conference of Multidisciplinary Approaches on UN Sustainable Development Goals (UNSDGs)*, 2017, no. Dec.

[11] M. A. Masrur *et al.*, "Military-Based Vehicle-to-Grid and Vehicle-to-Vehicle Microgrid—System Architecture and Implementation," *IEEE Trans. Transp. Electrif.*, vol. 4, no. 1, pp. 157–171, Mar. 2018, doi: 10.1109/TTE.2017.2779268.

[12] M. T. Hussain, D. N. Bin Sulaiman, M. S. Hussain, and M. Jabir, "Optimal Management strategies to solve issues of grid having Electric Vehicles (EV): A review," *J. Energy Storage*, vol. 33, no. November 2020, p. 102114, Jan. 2021, doi: 10.1016/j.est.2020.102114.

[13] Z. Salameh, "The Impact of Electric Vehicles on Utilities," *Int. J. Power Renew. Energy Syst.*, vol. 2, no. 2, pp. 2011–2014, 2015, [Online]. Available: www.as-se.org/ijpres.

[14] M. H. K. Tushar, C. Assi, M. Maier, and M. F. Uddin, "Smart Microgrids: Optimal Joint Scheduling for Electric Vehicles and Home Appliances," *IEEE Trans. Smart Grid*, vol. 5, no. 1, pp. 239–250, Jan. 2014, doi: 10.1109/TSG.2013.2290894.