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Energy Management Strategy for Vehicle-to-Grid Technology Integration with Energy Sources: Mini review

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ABSTRACT: Energy Management Strategies (EMSs) are used to monitor and control flown power in micro-grid systems. Choosing proper control management can cause unbalance in the power system. This paper presented the used sources to generate electricity in order to feed electric appliances in either or combined forms as renewable and non-renewable energy sources charge and discharge Electric Vehicles (EV) in form of Vehicle-to-Grid (V2G) technology. The classifications of RESs, EVs, and the EMSs were discussed along with their sub-classifications. The considered objectives for energy sources are cost, reliability, and renewability in order to obtain a cost-effective system, low power losses, and a renewable hybrid system. This short communication review is expected to be the best guide for researchers and students who working in the same field.

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1. Introduction

Vehicle-to-Grid (V2G) is a technology promising to overcome the charging/discharging using Renewable Energy Sources (RESs) and utility grid integration limitation [1]. Without using an energy control strategy, the challenges are continued [2]. The energy control strategy presented in various studies implemented for many power systems in order to smoothly split the power among the system components smoothly is three [3], [4]. The focus consideration of industrials and countries to reduce the consumption of utilizing fossil fuels and replace by RESs to supply systems and achieve the target of sharing Electric Vehicles (EVs) technology [5]. There were many exciting studies [6]. Another study is [7]. Considering of study the RESs sizing integration and cost analysis [8]. Different evaluation approaches can be used to optimize systems (Grid-connected and Grid-isolated) [9]. The aforementioned study considers the system cost and system reliability to be reduced considering various methods. another conducted study considering the Energy Management Strategies (EMS) for obtaining an optimal cost and energy storage system utilizing RESs as hybrid microgrid grids in modernized communities [10].

The rest of the article is organized as follows: Section 2 represents the classification of different RESs and N-RESs as irreplaceable life sources. The comparison between the electric vehicles has been discussed in Section 3. While the different types of energy, management strategies with their groups were discussed in Section 4.

Eventually, the conclusion of the article along with acknowledgment and a list of references located in the last section.

2. Renewable Energy Sources

RESs are sources that are able to be new in nature. We assume using residential and commercial for charging electric vehicles which integrated with either RESs or Non-renewable energy sources as the classification of the sources demonstrated in Fig. 1 [11]. When utilizing RESs, the atmosphere will be protected, on the other hand, while using fossil fuel sources will cause pollution and other power problems. According to presented state-of-the-art related to the V2G integration system with RESs integration using adjustable robust optimization [2]. Another conducted a study that combined two EVs strategies in order to increase the market share [12].

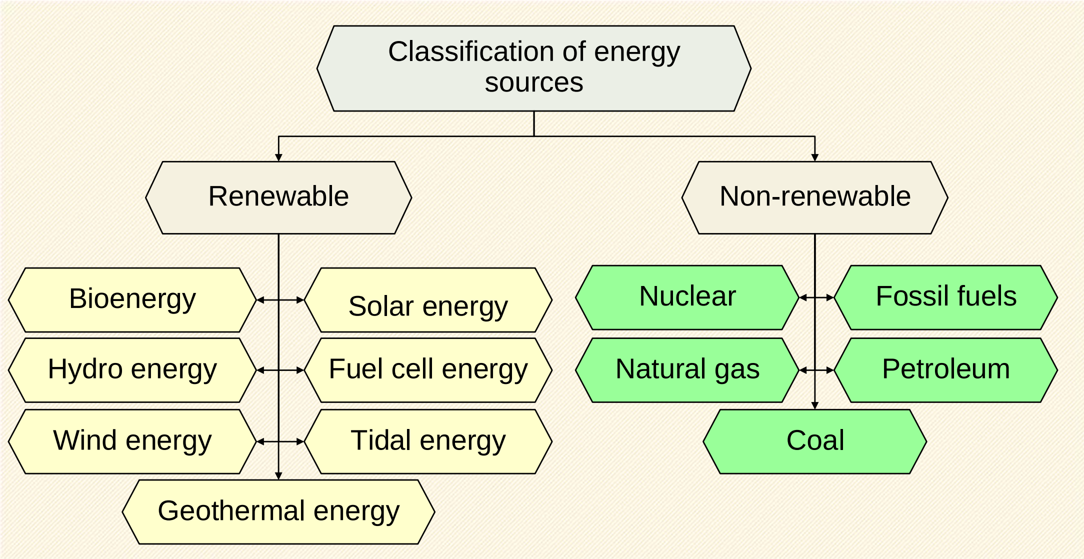
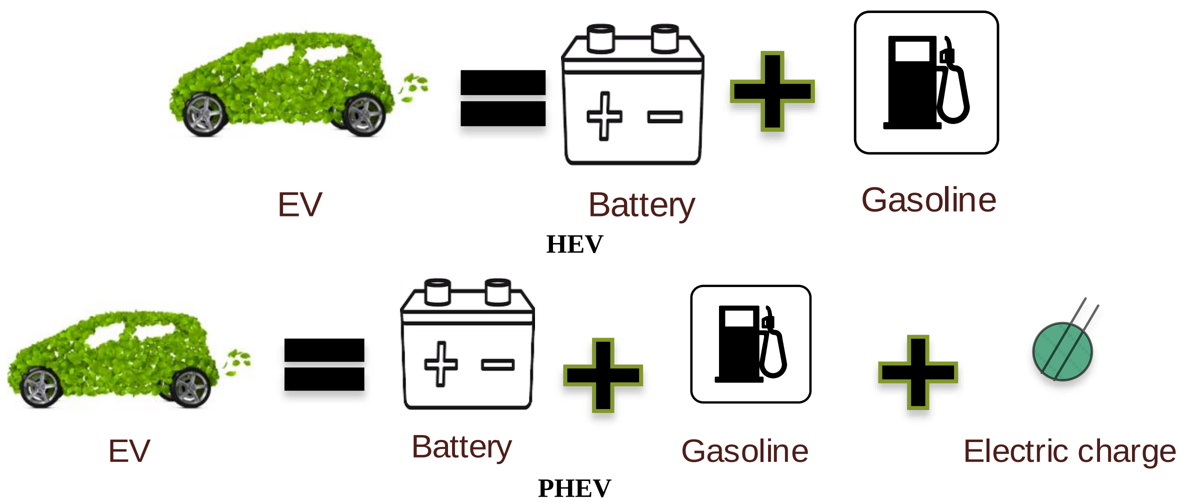
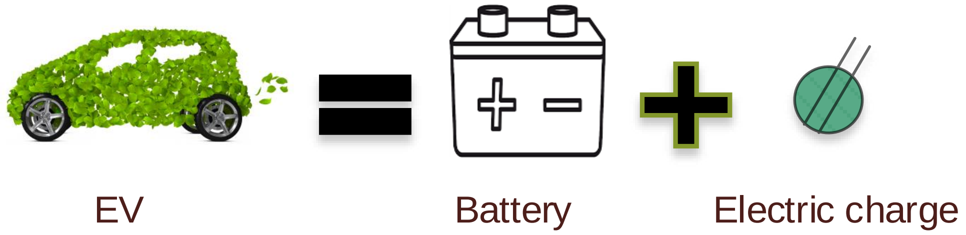


Figure 1 Classification of Renewable Energy Sources.

3. Comparison of Electric vehicles

Currently studied approved that the most polluted areas were due to the Internal Composition Engine (ICE) [13]. To overcome the aforementioned challenge by using EVs [14]. The numerous types of EVs are demonstrated in Fig. 2 along with the advantages, drawbacks, and the examples of the different types of each vehicle are as a sample are tabulated in Table 1 [15]. Besides the conventional vehicle that is widely used, the Hybrid Electric Vehicle (HEV), plug-in Hybrid Electric Vehicle (PHEV), and Battery Electric Vehicle (BEV) are exploited to address ICE limitations [16]. Battery EV and PHEV can be plugged into the grid for charging [17], [18].





BEV

Figure 2 Classifications of Electric Vehicles [15].

Table 1 Pros, Cons, and Types of Electric Vehicles.

	HEV	PHEV	BEV
Pros	• Longer driver range than BEV • Lower fuel consumption compare to ICE-based vehicle • Chapter compare to ICE-based vehicles • Lower emissions than ICE-based engines	• Long driving range • Low fuel consumption than ICE-based vehicle • Low emission of pollution in the environment • Use larger batter than HEV	• Zero tailpipe emission • No need for gas or oil refuelling • Easy to be charged at home • Fast and smooth acceleration • Overall low cost of operation
Cons	• Zero tailpipe emission is not achieved • The mechanism of operation is complex • Expensive to operate as compared to BEVs	• Environmental pollution is not eliminated • Expensive to operate as compared to BEV	• Shorter drive range as compared to ICE-based vehicles • Expensive than an ICE-based vehicle
Types	• Audi Q5 Hybrid • Acura ILX Hybrid • Cadilac Escalade Hybrid • BMW Active Hybrid 3 • BMW Active Hybrid 5 • BMW Active Hybrid 7 • Honda Civic Hybrid • Honda CR-Z Hybrid	• BMW i3 • BMW i8 Cadillac ELR • GM Chevy Volt • Porche SE • Ford Fusion Energi • Ford Cmax Energi • Toyota Prius Plugin	• Tesla Model S • Nissan Leaf • BMW i3 • Mitsubishi iMiEV • Smart EV • Ford Focus EV

4. Comparison of Energy Management Strategies

The different types of EMS as supervisory control have been presented in the literature in various applications with their classification, prons, and cons [3], [4]. Using for residential load charging [19]. The EMS can be classified into three groups as listed below:

1. Optimization-based (low-level control).
   - Global optimization-based (offline).
   - Real-time optimization-based (online).
2. Rule-based (high-level control).
   - Deterministic.
   - Fuzzy logic-based.
3. Learning-based.
   - Supervised.
   - Unsupervised.
   - Neural network.
   - Reinforcement.

The OB has used complex mathematical equations in order to address the optimization problems for micro-grid systems, however, the provided result is not as accurate as of the RB result [3], [20]. While the RB depends on the human plan and making a fast decision and providing exact results [21], [22]. The last-mentioned type is LB which is used in data mining, Artificial Intelligence (AI), machine learning in order to derive the optimal control law for real-time information [3]. Moreover, LB can learn from the historical data. However, its time consuming and a very hard method for making data structure [23].

Conclusion

In this short article, controlling methods for splitting the power among the micro-grid systems smoothly have been discussed with the EMSs to gain a reliable and integrated operation reduced cost system. The renewable energy sources classification has been briefly discussed for V2G integration. Besides, EVs provide less pollution and protect the environment in their different forms as has been figured in Fig. 2 with their pros, cons, and types. The authors suggested for the aforesaid RESs and conventional sources in terms of integration to utilize them in future studies.

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References

[1] A. Alsharif, T. C. Wei, R. Ayop, K. Y. Lau, and A. L. Bukar, "A Review of the Smart Grid Communication Technologies in Contactless Charging with Vehicle to Grid Integration Technology," *J. Integr. Adv. Eng.*, vol. 1, no. 1, pp. 11–20, Apr. 2021, doi: 10.51662/jiae.v1i1.8.

[2] R. Shi, S. Li, P. Zhang, and K. Y. Lee, "Integration of renewable energy sources and electric vehicles in V2G network with adjustable robust optimization," *Renew. Energy*, vol. 153, pp. 1067–1080, 2020, doi: 10.1016/j.renene.2020.02.027.

[3] D. D. Tran, M. Vafaeipour, M. El Baghdadi, R. Barrero, J. Van Mierlo, and O. Hegazy, "Thorough state-of-the-art analysis of electric and hybrid vehicle powertrains: Topologies and integrated energy management strategies," *Renew. Sustain. Energy Rev.*, vol. 119, p. 109596, 2020, doi: 10.1016/j.rser.2019.109596.

[4] A. Alsharif, C. W. Tan, R. Ayop, A. Dobi, and K. Y. Lau, "A comprehensive review of energy management strategy in Vehicle-to-Grid technology integrated with renewable energy sources," *Sustain. Energy Technol. Assessments*, vol. 47, no. xxxx, p. 101439, Oct. 2021, doi: 10.1016/j.seta.2021.101439.

[5] G. Salvatti, E. Carati, R. Cardoso, J. da Costa, and C. Stein, "Electric Vehicles Energy Management with V2G/G2V Multifactor Optimization of Smart Grids," *Energies*, vol. 13, no. 5, p. 1191, Mar. 2020, doi: 10.3390/en13051191.

[6] S. F. Tie and C. W. Tan, "A review of energy sources and energy management system in electric vehicles," *Renew. Sustain. Energy Rev.*, vol. 20, pp. 82–102, 2013, doi: 10.1016/j.rser.2012.11.077.

[7] M. A. Hannan, M. M. Hoque, A. Hussain, Y. Yusof, and P. J. Ker, "State-of-the-Art and Energy Management System of Lithium-Ion Batteries in Electric Vehicle Applications: Issues and Recommendations," *IEEE Access*, vol. 6, pp. 19362–19378, Mar. 2018, doi: 10.1109/ACCESS.2018.2817655.

[8] F. A. Khan, N. Pal, and S. H. Saeed, "Review of solar photovoltaic and wind hybrid energy systems for sizing strategies optimization techniques and cost analysis methodologies," *Renew. Sustain. Energy Rev.*, vol. 92, pp. 937–947, Sep. 2018, doi: 10.1016/j.rser.2018.04.107.

[9] T. Tezer, R. Yaman, and G. Yaman, "Evaluation of approaches used for optimization of stand-alone hybrid renewable energy systems," *Renew. Sustain. Energy Rev.*, vol. 73, no. February, pp. 840–853, Jun. 2017, doi: 10.1016/j.rser.2017.01.118.

[10] A. Merabet, A. Al-Durra, and E. F. El-Saadany, "Energy management system for optimal cost and storage utilization of renewable hybrid energy microgrid," *Energy Convers. Manag.*, vol. 252, no. October 2021, p. 115116, Jan. 2022, doi: 10.1016/j.enconman.2021.115116.

[11] M. H. K. Tushar, A. W. Zeineddine, and C. Assi, "Demand-Side Management by Regulating Charging

and Discharging of the EV, ESS, and Utilizing Renewable Energy," *IEEE Trans. Ind. Informatics*, vol. 14, no. 1, pp. 117–126, Jan. 2018, doi: 10.1109/TII.2017.2755465.

[12] D. Borge-Diez, D. Icaza, E. Açıkkalp, and H. Amaris, "Combined vehicle to building (V2B) and vehicle to home (V2H) strategy to increase electric vehicle market share," *Energy*, vol. 237, p. 121608, Dec. 2021, doi: 10.1016/j.energy.2021.121608.

[13] S. M. Arif, T. T. Lie, B. C. Seet, S. Ayyadi, and K. Jensen, "Review of Electric Vehicle Technologies, Charging Methods, Standards and Optimization Techniques," *Electronics*, vol. 10, no. 16, p. 1910, Aug. 2021, doi: 10.3390/electronics10161910.

[14] S. R. Revankar and V. N. Kalkhambkar, "Grid integration of battery swapping station: A review," *J. Energy Storage*, vol. 41, no. May, p. 102937, 2021, doi: 10.1016/j.est.2021.102937.

[15] J. A. Sanguesa, V. Torres-Sanz, P. Garrido, F. J. Martinez, and J. M. Marquez-Barja, "A Review on Electric Vehicles: Technologies and Challenges," *Smart Cities*, vol. 4, no. 1, pp. 372–404, Mar. 2021, doi: 10.3390/smartcities4010022.

[16] 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.

[17] N. Shaukat *et al.*, "A survey on electric vehicle transportation within smart grid system," *Renew. Sustain. Energy Rev.*, vol. 81, no. May 2017, pp. 1329–1349, Jan. 2018, doi: 10.1016/j.rser.2017.05.092.

[18] B. Bibak and H. Tekiner-Moğulkoç, "A comprehensive analysis of Vehicle to Grid (V2G) systems and scholarly literature on the application of such systems," *Renew. Energy Focus*, vol. 36, no. March, pp. 1–20, Mar. 2021, doi: 10.1016/j.ref.2020.10.001.

[19] V. Muthiah-Nakarajan, S. H. C. Cherukuri, B. Saravanan, and K. Palanisamy, "Residential energy management strategy considering the usage of storage facilities and electric vehicles," *Sustain. Energy Technol. Assessments*, vol. 45, no. March, p. 101167, 2021, doi: 10.1016/j.seta.2021.101167.

[20] M. F. M. Yusof and A. Z. Ahmad, "Power energy management strategy of micro-grid system," *Proc. - 2016 IEEE Int. Conf. Autom. Control Intell. Syst. I2CACIS 2016*, no. October, pp. 107–112, 2017, doi: 10.1109/I2CACIS.2016.7885298.

[21] A. Alsharif, C. W. Tan, R. Ayop, K. Y. Lau, and C. L. Toh, "Sizing of Photovoltaic Wind Battery system integrated with Vehicle-to-Grid using Cuckoo Search Algorithm," in *2021 IEEE Conference on Energy Conversion (CENCON)*, Oct. 2021, pp. 22–27, doi: 10.1109/CENCON51869.2021.9627291.

[22] Y. Huang, H. Wang, A. Khajepour, H. He, and J. Ji, "Model predictive control power management strategies for HEVs: A review," *J. Power Sources*, vol. 341, pp. 91–106, Feb. 2017, doi: 10.1016/j.jpowsour.2016.11.106.

[23] R. Liu, D. Shi, and C. Ma, "Real-Time Control Strategy of Elman Neural Network for the Parallel Hybrid Electric Vehicle," *J. Appl. Math.*, vol. 2014, pp. 1–11, 2014, doi: 10.1155/2014/596326.