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Electric Vehicle Contribution for Sustainable Development Goal

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Abstract:
Electric Vehicles (EVs) play a significant role in contributing to sustainable development. By eliminating or reducing the reliance on fossil fuels, EVs help to mitigate Greenhouse Gas (GHG) emissions and combat climate change. They have zero tailpipe emissions, resulting in cleaner air quality and improved public health. Moreover, the integration of renewable energy sources for charging EVs further enhances their environmental benefits. Furthermore, the use of EVs reduces dependency on imported oil and increases energy independence for countries. This enhances energy security and reduces geopolitical risks associated with fossil fuel dependence. Moreover, the decentralization of energy through vehicle-to-grid integration allows EVs to serve as energy storage units, contributing to a more balanced and resilient electricity grid.

Keywords: EV, GHG, RESs, Climate change.

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مساهمة المركبات الكهربائية في تحقيق هدف التنمية المستدامة

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الملخص
تلعب المركبات الكهربائية دورًا مهمًا في المساهمة في التنمية المستدامة. من خلال القضاء على الاعتماد على الوقود الأحفوري أو الحد منه، تساعد المركبات الكهربائية في التخفيف من انبعاثات غازات الاحتباس الحراري *(GHG)* ومكافحة تغير المناخ. ليس لديهم أي انبعاثات من أنبوب العادم، مما يؤدي إلى جودة هواء أنظف وتحسين الصحة العامة. علاوة على ذلك، فإن تكامل مصادر الطاقة المتجددة لشحن المركبات الكهربائية يعزز فوائدها البيئية. علاوة على ذلك، يقلل استخدام المركبات الكهربائية من الاعتماد على النفط المستورد ويزيد من استقلالية الطاقة للبلدان. هذا يعزز أمن الطاقة ويقلل من المخاطر الجيوسياسية المرتبطة بالاعتماد على الوقود الأحفوري. علاوة على ذلك، تسمح لامركزية الطاقة من خلال التكامل بين السيارة والشبكة للمركبات الكهربائية بالعمل كوحدات تخزين للطاقة، مما يساهم في شبكة كهرباء أكثر توازناً ومرونة.

الكلمات المفتاحية: المركبات الكهربائية، GHG، RESs، تغير المناخ.

1. Introduction

Electric vehicles (EVs) play a crucial role in sustainable development [1]. The integration of EV with RESs could causes a positive impact on environment, economic, energy security, and sustainability [2]. EVs also contribute to energy efficiency as they have higher conversion efficiency compared to conventional internal combustion engine vehicles (ICEV) [2]. This leads to reduced energy consumption and a more sustainable use of resources [3]. Additionally, the growing adoption of EVs promotes technological advancements and innovation, creating green job opportunities and economic growth in the renewable energy and automotive sectors [4]. Furthermore, EV contribute to sustainable development by reducing greenhouse gas emissions, improving air quality, promoting energy efficiency, fostering technological innovation, creating green jobs, and enhancing energy security [5].

Optimize your driving style to reduce fuel consumption could drive smoothly and at lower speeds on motorways, close windows at high speeds and make sure your tires are properly inflated [6]. Moreover, trying to avoid busy roads whenever possible, and shut off the engine when stationary. Drive 10 km/h slower on motorways to cut your fuel bill by around EUR 60 per year. Another way to save fuel is to maintain a constant speed between 50 and 90 km/h [7]. When driving faster than 80 km/h, it's more efficient to use A/C, rather than opening your windows. And service your engine regularly to maintain energy efficiency.

Various studies conducted in the literature for the utilization of EV role towards the sustainability as a hot topic among scholars in urban and rural regions [5], [8], [9]. The EV align closely with sustainable development goals by reducing carbon emissions, improving air quality, promoting renewable energy integration, and contributing to a greener and more sustainable future [10].

This article contribution is by investigating the integration of EV with RES in order to meet the demand and shifting to green environment. Besides, the main key factors of being sustainable is taken in consideration. The rest of the article is organized as follows: the methods and materials considering the way towards sustainability along with the proposed system are shown in Section 2. The modeling of the proposed system along with their mathematical equation is presented in Section 3. Section 4 is presenting and discussing the acquired results and analysis. Finally, the closing of the article with the summary conclusion and list of recent references.

2. Methods and materials

Electric vehicles (EVs) contribute to sustainable development in several ways as demonstrated in Figure 1. Besides, EV offer a significant opportunity to reduce environmental harm, combat climate change, improve air quality, and promote sustainable development in the transportation sector [11]. While the proposed system is presented in Figure 2 consists of PV, BT, and EV implemented in home load.

Figure 1. Ways of EV for sustainability [12]–[14].

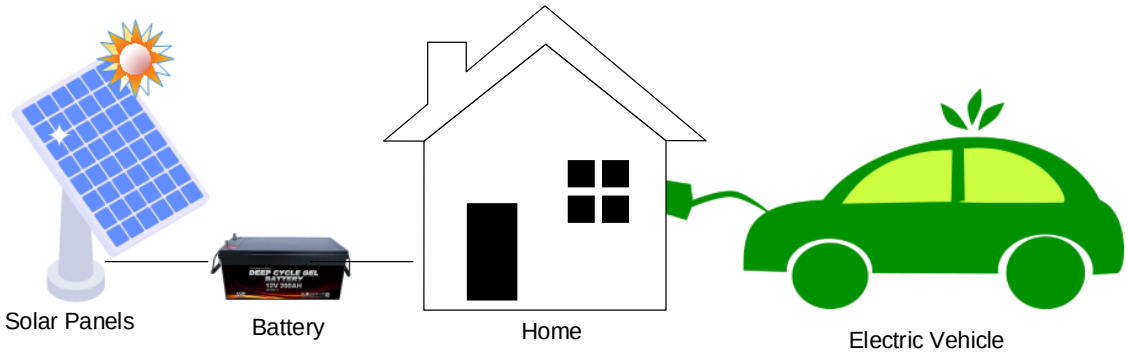

Figure 2. Proposed diagram.

3. Modeling of the proposed system

Renewable energy and environmentally friendly transportation both depend on photovoltaic (PV) systems, battery systems, and electric vehicle (EV) system components [15].

3.1 PV

The PV systems, commonly known as solar power systems, convert sunlight into electricity that used to generate clean and renewable electricity for residential, commercial, and utility-scale applications [16]. The estimation of calculating the output power from the PV is presented in Eq. (1) [17].

$$P_{pv_{out}}(t) = P_{(PV_{rated})*}\frac{G_{(t)}}{1000} * [1 + \alpha_t((T_{amb} + (0.03125 * G_t)) - T_{C_{STC}} \quad (1)$$

where $P_{pv_{out}}$ is the assessed power from PV at time (t), 1000 is reference irradiance, T_{amb} is the ambient temperature, G_t is the solar irradiance, the α_t is the temperature coefficient that equals -3.7x10-3, and the $T_{C_{STC}}$ is the cell temperature.

3.2 EV

The EV system includes various components that enable electric vehicles to operate using lithium-ion battery [18]. EVs are propelled by electric motors powered by energy stored in their batteries, offering an environmentally friendly alternative to ICEV [19]. The estimated output power from the EV can be mathematically calculated as expressed in Eq. (2).

$$P_{EV_{Dem}} = \frac{C_{BT}^{EV} \times \left(SoC_{Max}^{EV} - SoC_{Min}^{EV}\right)}{T} \quad (2)$$

Equation presented the mathematical equation for the power demand from the EV ($P_{EV_{Dem}}$), the C_{BT}^{EV} is the capacity of EV battery, the SoC_{Max}^{EV} and SoC_{Min}^{EV} are the maximum and minimum state of charge of EV battery, respectively. The T refers to the time of departure and arrival EV to the charging station.

3.3 BT

Battery systems store electrical energy for later use considering RESs to excess the electricity into the BT [20]. By storing excess energy and delivering it when demand is high or when solar generation is low, battery systems enhance overall energy utilization and enable smooth power supply [21]. The generated power from the battery to meet the demand in the cases of PV is not sufficient to meet the demand using Eq. (3) [22].

$$P_{BT}(t) = \left(\left(P_{pv}(t) \right) - \frac{P_l(t)}{\eta_{inv}} \right) \quad (3)$$

Equation 3 represented the output power from the battery (P_{BT}) at time (t), η_{inv} the inverter efficiency, $P_l(t)$ is represents the load demand of the study site, and $P_{pv}(t)$ is the estimated output power from the PV.

4. Results and discussion

Based on the model system hat illustrated in Figure 2, the acquired result are plotted in Figure 3. Based on the Eq. (1) the acquired result of PV output is presented. Furthermore, according to the amount of solar radiation the study site, the energy will be generated in order to meet the demand. The presented energy is for the first 24 hours of the PV energy with fluctuation in energy due to the time of generation through solar panels. While Figure 4 demonstrated the comparison of output power among the considered sources in this study. Considering the operation of exchanging the power between the PV and EV. It meets the demand and providing sustainable system.

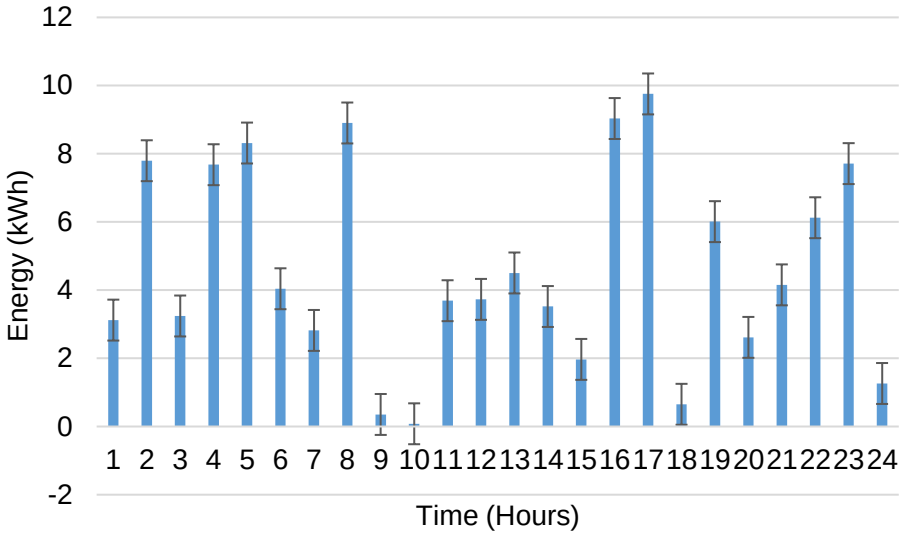

Figure 3. PV output energy produced to charge electric vehicle.

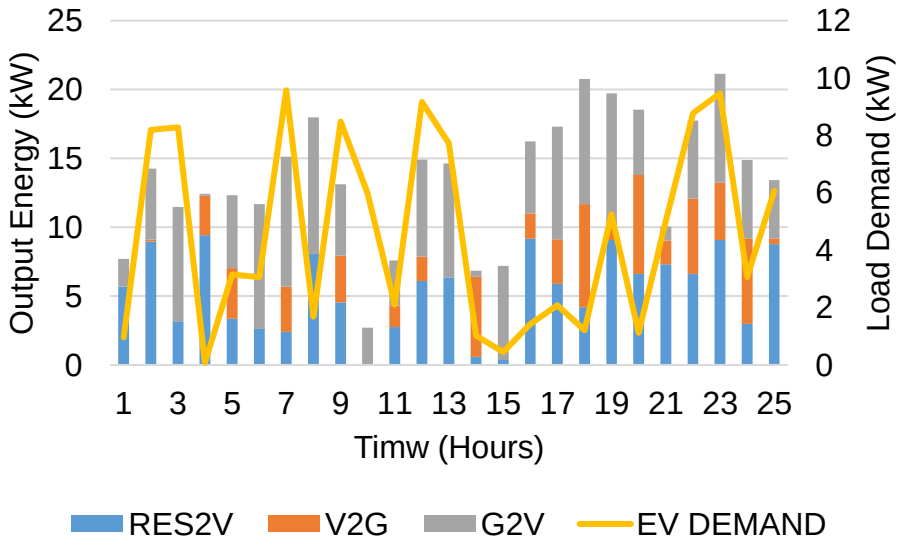

Figure 4. V2G and G2V monthly output energy.

Conclusion

In conclusion, EV play a crucial role in contributing to sustainable development. By replacing conventional internal combustion engine cars, EVs help reduce GHG emissions, combat air pollution, and improve overall air quality. They contribute to reducing our dependence on fossil fuels by utilizing RESs for charging. EVs also offer the potential for energy storage and grid integration, enabling more efficient and reliable electricity systems. Moreover, widespread adoption of EVs promotes technological advancements, job creation, and economic growth in the clean energy sector. Moreover, EVs are an essential component of sustainable transportation and a key solution for achieving a more sustainable future. Further studies should be considered on environmental Impact in order to reduce air pollution and GHG emission by transitioning from conventional vehicles into EV. Additionally, reduce reliance on fossil fuels and encourage the adoption of sustainable energy sources by connecting RESs to run other appliances and charge EVs.

References

[1] M. Bilal, M. Rizwan, I. Alsaidan, and F. M. Almasoudi, "AI-Based Approach for Optimal Placement of EVCS and DG with Reliability Analysis," *IEEE Access*, vol. 9, pp. 154204–154224, 2021, doi: 10.1109/ACCESS.2021.3125135.

[2] L. Canals Casals, E. Martinez-Laserna, B. Amante García, and N. Nieto, "Sustainability analysis of the electric vehicle use in Europe for CO2 emissions reduction," *J. Clean. Prod.*, vol. 127, pp. 425–437, Jul. 2016, doi: 10.1016/j.jclepro.2016.03.120.

[3] B. Bacar, A. Almaktoof, A. M. Khalat, and M. K. Elmezughi, "Smart metering and energy access programs: An approach to energy poverty reduction in sub-Saharan Africa," in *2022 IEEE 2nd International Maghreb Meeting of the Conference on Sciences and Techniques of Automatic Control and Computer Engineering, MI-STA 2022 - Proceeding*, 2022, no. May, pp. 127–132, doi: 10.1109/MI-STA54861.2022.9837661.

[4] F. R. Albogamy *et al.*, "Real-Time Energy Management and Load Scheduling with Renewable Energy Integration in Smart Grid," *Sustainability*, vol. 14, no. 3, p. 1792, Feb. 2022, doi: 10.3390/su14031792.

[5] A. M. A. Haidar, A. Fakhar, and A. Helwig, "Sustainable energy planning for cost minimization of autonomous hybrid microgrid using combined multi-objective optimization algorithm," *Sustain. Cities Soc.*, vol. 62, p. 102391, 2020, doi: https://doi.org/10.1016/j.scs.2020.102391.

[6] 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, Jun. 2020, doi: 10.1016/j.renene.2020.02.027.

[7] D. Tokar, D. Foris, A. Tokar, and T. Foris, "Sustainable development of disadvantaged regions by renewable energy sources integration," *20th Int. Sci. Conf. "Economic Sci. Rural Dev. 2019". Integr. Sustain. Reg. Dev. Mark. Sustain. Consum.*, vol. 51, no. 51, pp. 237–244, 2019, doi: 10.22616/esrd.2019.081.

[8] M. Shafiullah *et al.*, "Review of Recent Developments in Microgrid Energy Management Strategies," *Sustainability*, vol. 14, no. 22, p. 14794, Nov. 2022, doi: 10.3390/su142214794.

[9] T. Sarkar, A. Bhattacharjee, H. Samanta, K. Bhattacharya, and H. Saha, "Optimal design and implementation of solar PV-wind-biogas-VRFB storage integrated smart hybrid microgrid for ensuring zero loss of power supply probability," *Energy Convers. Manag.*, vol. 191, no. January, pp. 102–118, 2019, doi: 10.1016/j.enconman.2019.04.025.

[10] A. Alsharif *et al.*, "Impact of Electric Vehicle on Residential Power Distribution Considering Energy Management Strategy and Stochastic Monte Carlo Algorithm," *Energies*, vol. 16, no. 3, p. 1358, Jan. 2023, doi: 10.3390/en16031358.

[11] M. Jafari, M. Korpås, and A. Botterud, "Power system decarbonization: Impacts of energy storage duration and interannual renewables variability," *Renew. Energy*, vol. 156, pp. 1171–1185, Aug. 2020, doi: 10.1016/j.renene.2020.04.144.

[12] L. Noel, G. Zarazua de Rubens, J. Kester, and B. K. Sovacool, "The Technical Challenges to V2G," in *Vehicle-to-Grid*, Cham: Springer International Publishing, 2019, pp. 65–89.

[13] S. Hovet, B. Farley, J. Perry, K. Kirsche, M. Jerue, and Z. Tse, "Introduction of Electric Vehicle Charging Stations to University Campuses: A Case Study for the University of Georgia from 2014 to 2017," *Batteries*, vol. 4, no. 2, p. 27, Jun. 2018, doi: 10.3390/batteries4020027.

[14] M. Rasti-Barzoki and I. Moon, "A game theoretic approach for analyzing electric and gasoline-

based vehicles' competition in a supply chain under government sustainable strategies: A case study of South Korea," *Renew. Sustain. Energy Rev.*, vol. 146, no. April, p. 111139, Aug. 2021, doi: 10.1016/j.rser.2021.111139.

[15] M. Liu, P. K. Phanivong, Y. Shi, and D. S. Callaway, "Decentralized Charging Control of Electric Vehicles in Residential Distribution Networks," *IEEE Trans. Control Syst. Technol.*, vol. 27, no. 1, pp. 266–281, Jan. 2019, doi: 10.1109/TCST.2017.2771307.

[16] S. A. Aleem, S. M. S. Hussain, and T. S. Ustun, "A Review of Strategies to Increase PV Penetration Level in Smart Grids," *Energies*, vol. 13, no. 3, p. 636, Feb. 2020, doi: 10.3390/en13030636.

[17] 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)*, 2021, pp. 22–27, doi: 10.1109/CENCON51869.2021.9627291.

[18] X. Tian, Y. Cai, X. Sun, Z. Zhu, and Y. Xu, "A Novel Energy Management Strategy for Plug-in Hybrid Electric Buses Based on Model Predictive Control and Estimation of Distribution Algorithm," *IEEE/ASME Trans. Mechatronics*, pp. 1–12, 2022, doi: 10.1109/TMECH.2022.3156150.

[19] A. Alsharif, C. W. Tan, R. Ayop, A. Ali Ahmed, M. Mohamed Khaleel, and A. K. Abobaker, "Power Management and Sizing Optimization for Hybrid Grid-Dependent System Considering Photovoltaic Wind Battery Electric Vehicle," in *2022 IEEE 2nd International Maghreb Meeting of the Conference on Sciences and Techniques of Automatic Control and Computer Engineering (MI-STA)*, 2022, no. May, pp. 645–649, doi: 10.1109/MI-STA54861.2022.9837749.

[20] R. Mkhal, A. Nait-Sidi-Moh, and M. Wack, "Modeling and Simulation of Standalone Photovoltaic Charging Stations for Electric Vehicles," *Int. J. Comput. Inf. Eng.*, vol. 9, no. 1, pp. 72–80, 2015.

[21] 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.

[22] S. Barakat, H. Ibrahim, and A. A. Elbaset, "Multi-objective optimization of grid-connected PV-wind hybrid system considering reliability, cost, and environmental aspects," *Sustain. Cities Soc.*, vol. 60, no. March, p. 102178, Sep. 2020, doi: 10.1016/j.scs.2020.102178.

[23] A. A. Ahmed and A. F. Saleh Alshandoli, "Using Of Neural Network Controller And Fuzzy PID Control To Improve Electric Vehicle Stability Based On A14-DOF Model," 2020 International Conference on Electrical Engineering (ICEE), Istanbul, Turkey, 2020, pp. 1-6, doi: 10.1109/ICEE49691.2020.9249784.

[24] M. M. Khaleel, Z. Yusupov, M. T. Güneşer, A. A. Abulifa, A. A. Ahmed and A. Alsharif, "The Effect of PEMFC on Power Grid Using Advanced Equilibrium Optimizer and Particle Swarm Optimisation for Voltage Sag Mitigation," 2023 IEEE 3rd International Maghreb Meeting of the Conference on Sciences and Techniques of Automatic Control and Computer Engineering (MI-STA), Benghazi, Libya, 2023, pp. 755-760, doi: 10.1109/MI-STA57575.2023.10169228.

[25] A. Alsharif, A. A. Ahmed, M. M. Khaleel, A. S. Daw Alarga, O. S. M. Jomah and I. Imbayah, "Comprehensive State-of-the-Art of Vehicle-To-Grid Technology," 2023 IEEE 3rd International Maghreb Meeting of the Conference on Sciences and Techniques of Automatic Control and Computer Engineering (MI-STA), Benghazi, Libya, 2023, pp. 530-534, doi: 10.1109/MI-STA57575.2023.10169116.