World Electric Vehicle Journal

MDPI

*Editorial*

# Electric Vehicles—Solution toward Zero Emission from the Transport Sector

**Aritra Ghosh**

College of Engineering, Mathematical and Physical Sciences, University of Exeter, Cornwall TR10 9FE, UK; a.ghosh@exeter.ac.uk

## 1. Introduction

Internal combustion engine (ICE)-based vehicles have contributed considerably to air pollution. Displacement of this ICE engine with electric vehicles (EV) is one of the potential choices which can abate air pollution and make vehicles independent from oil. EVs are not only limited to just full-sized cars but also include two- and three-wheeled vehicles, which are a popular transport medium in developing countries. Batteries, ultracapacitors, and fuel cells are the energy sources for EV. Depending on the EV type, one or multiple of these sources can be used in an EV. However, integration of the EV in the transport sector has major obstacles, including battery cost and efficiencies, the potential of the EV charging station, and the impact of EV integration on the grid. In addition, consumer readiness and willingness to pay and accept are also non-ignorable factors that limit the widespread implementation of EVs. As it is evident that EVs have the potential to contribute to the decarbonization of transportation, this Special Issue invites original papers and review articles on all aspects connected to EVs, batteries, fuel cells, and capacitor and consumer perspectives for EV uptake.

The Special Issue entitled "Electric Vehicles—Solution toward Zero Emission from the Transport Sector" was focused on many aspects of EVs, including the following:

- Electric vehicles;
- Battery energy management for EV;
- Fuel cell for EV;
- Battery for EV;
- Capacitor for EV;
- EV charging infrastructure;
- Grid integration.

This Special Issue highlighted a variety of topics related to sensors and sensor's fusion in autonomous vehicles. The sequence of articles included in this Special Issue is in line with the latest scientific trends. The latest developments in science, including artificial intelligence, were used. A total of 14 papers (from 20 submitted) were published.

In this article, we provide a brief overview of the published papers, in particular the use of advanced modern technologies and data fusion techniques. These two areas seem to be heading in the right direction for the future development of autonomous vehicles navigation.

## 2. Overview of Contribution

EVs are considered to be the future for the transport sector. However, a shift from fossil fuel-driven vehicles to EVs is not that simple. Major challenges for EV adoption include range anxiety, social, and economic. To improve the social impact, a strong sustainable development goal proposed by the government must be implemented [1]. To understand how drivers play a key role in EV adoption, surveys were conducted in the Philippines, where economic, environmental, legal, political, social, and technical factors

check for updates

**Citation:** Ghosh, A. Electric Vehicles—Solution toward Zero Emission from the Transport Sector. *World Electr. Veh. J.* **2021**, *12*, 262. https://doi.org/10.3390/wevj12040262

Received: 1 December 2021
Accepted: 6 December 2021
Published: 13 December 2021

were the variables. It was observed that economic and technological factors had the highest influence to act as barriers against choosing EV. High investment and operational costs, lack of charging infrastructure, issues in driving range and use in different terrains, and the availability of EV parts and repair stations are among the reasons why drivers are reluctant to accept EV. Authors also identified that government support is essential to make EV a daily mode of use [2]. Availability, reliability, and maintainability of electrical components of an EV, namely battery, motor, drive, controllers, charging unit, and energy management unit, are key for the large scale utilization of EV. The use of the Markov Framework for quantitative RAM analysis of a plug-in electric vehicle showed that a vehicle's survivability can be increased by improving its components' restoration rates [3]. The powertrain nature of BEVs is not yet fully understood compared to ICE and also the presence of several electrical sensors in BEV makes the process and the cost of the EVs high. Thus, the manufacturer also should look into this matter considering the user's behaviours [4]. Range anxiety has already been discussed as an issue, however charge point trauma (CPT) is another mode or challenge. CPT is a combination of psychological, physiological, and behavioural conditions. EV users can often experience trauma or anxiety due to insufficient charge points, locations, payment processes, and operability. Considering the UK's condition, the authors concluded that this anxiety or trauma will remain until sufficient measures are taken. It is recommended that to increase the operational parity between EV charging stations and current fossil fuel filling stations, an increase in EV charging station access points on motorways and major trunk networks in the UK should be implemented. It is expected that these measures can de-risk the purchase of EVs and abate charge point trauma [5]. Another range anxiety issue can be reduced by employing range extenders, which can extend the driving range of EVs. EV range-extending technologies include internal combustion engines, free-piston linear generators, fuel cells, micro gas turbines, and zinc-air batteries [6]. EVs will be truly sustainable if the required power to charge the EVs come from renewable sources. Solar energy, which is one of the major renewable energy sources, can act as a power source for an EV charging station. The potential of solar powered EV charging stations in India, where the climate is hot and humid, was investigated. An 8.1 kWp off-grid system with two days of battery support can offer the lowest energy losses. It has the ability to charge 414 vehicles and has a 20 kWh annual battery capacity. This can also eliminate 7950 kg $CO_2$. It is also recommended that a location near to the equator can generate higher solar energy from January to March, while a location near the tropic of cancer has the ability during May–June [7].

Accurate prediction of battery dynamics is key for EV application. The Box- Jenkins model, which can use the transfer function to develop a relationship between input–outputs for a given system, was applied for a lithium-ion battery. It has the ability to capture adequately the battery dynamics under different automotive drive cycles. The Box-Jenkins model was performed by employing goodness of fit criteria, which showed that the model matches the battery cell data by 86.85% in the identification phase, and 90.83% in the validation phase for the LA-92 driving cycle [8]. Battery range capacity prediction analysis can reduce range anxiety. Machine learning (ML) models such as multiple linear regression (MLR), extreme gradient boosting (XGBoost), and support vector regression (SVR) were employed to understand the EVs total energy consumption. trip distance, tire type, driving style, power, odometer reading, EV model, city, motorway, country roads, air conditioning, and park heating were employed as input parameters and it was found that trip distance followed by power, heating, and odometer reading possesses higher correlation coefficient with TEC, while XBoost had the highest accuracy [9]. A case study was performed to understand the transition from ICE to plug-in EV on Hawaiian Island, which showed that the use of hybrid EVs can reduce fossil fuel consumption and lower $CO_2$ emission. By 2045, oil-powered vehicles, including freight and passenger, will consume a total of 8.8 billion gallons of gasoline, and EVs 0.090 billion gallons of gasoline. ICE $CO_2$ emissions will total 80 million metric tonnes, and EVs 4.4 million metric tonnes. The anticipated transition to

electric passenger and freight vehicles transition combined with renewable power has the ability to lead to 99% less fossil fuel consumption, and 93% less $CO_2$ emission by 2050 [10].

Battery EV obtain their power from the battery and the converter plays a crucial role in the conversion between power and signal. Thus, a reliable and stable converter is essential for BEV (improved diode neutral-point-clamped topology-based converter can switch between two-level and three-level modulation and extended fault-tolerant capacity is achievable [11]. Nickel-metal hydride (NiMH) battery and lithium-ion (Li-ion) are both now widely employed in EV because of their impressive energy density, good power density, and low self-discharge. However, to have a highly reliable battery, distribution of temperature is essential using fins and cooling agents. Optimized cooling flow and type of coolant play a crucial role to be determinants [12]. Accurate prediction of SOC of a battery management system is essential for EV. However, this non-linear behaviour prediction is a tedious task. Among the Six machine learning languages, which are artificial neural network (ANN), support vector machine (SVM), linear regression (LR), Gaussian process regression (GPR), ensemble bagging (EBa), and ensemble boosting (EBo); however, ANN and GPR acted best for prediction with less error [13]. For consumers, understanding the types of EV on the market is essential in terms of the different available car models and their classification. Work was developed for the Polish car market where 53 different EVs are available. Primarily, four different categories were developed which included size, class of the car, performance and overall quality of the vehicle [14]. In future, if this type of classification is available globally, EV adopters will benefit. In summary, it can be announced that battery management plays a crucial role in successful EV penetration in the transport sector. Enhanced charging and discharging rate and electrode thickness increase the battery temperature, which can be improved with the inclusion of a cooling agent [15].

## 3. Conclusions

To combat environmental pollution, sustainable transport, particularly electrification of the transport sector, is essential. However, several barriers still exist, such as societal, economic and technological. Researchers are still trying to obtain the best technological solution, while the government should develop strict policies to support EV penetration on the road.

**Funding:** This research received no external funding.

**Acknowledgments:** We would like to thank all the authors who contributed to the Special Issue and the staff in the editorial office.

**Conflicts of Interest:** The author declares no conflict of interest.

## References

1. Omahne, V.; Knez, M.; Obrecht, M. Social Aspects of Electric Vehicles Research—Trends and Relations to Sustainable Development Goals. *World Electr. Veh. J.* **2021**, *12*, 15. [CrossRef]
2. Guno, C.S.; Collera, A.A.; Agaton, C.B. Barriers and Drivers of Transition to Sustainable Public Transport in the Philippines every as. *World Electr. Veh. J.* **2021**, *12*, 46.
3. Talukdar, B.K.; Deka, B.C. An Approach to Reliability, Availability and Maintainability Analysis of a Plug-In Electric Vehicle. *World Electr. Veh. J.* **2021**, *12*, 34. [CrossRef]
4. König, A.; Nicoletti, L.; Lienkamp, M.; Schröder, D.; Wolff, S.; Waclaw, A. An Overview of Parameter and Cost for Battery Electric Vehicles. *World Electr. Veh. J.* **2021**, *12*, 21. [CrossRef]
5. Chamberlain, K.; Majeed, S. Al Evaluating the Barrier Effects of Charge Point Trauma on UK Electric Vehicle Growth. *World Electr. Veh. J.* **2021**, *12*, 152. [CrossRef]
6. Tran, M.; Bhatti, A.; Vrolyk, R.; Wong, D.; Panchal, S.; Fowler, M.; Fraser, R. A Review of Range Extenders in Battery Electric Vehicles: Current Progress and Future Perspectives. *World Electr. Veh. J.* **2021**, *12*, 54. [CrossRef]
7. Singh, A.; Shaha, S.S.; Nikhil, P.G.; Sekhar, Y.R.; Saboor, S.; Ghosh, A. Design and Analysis of a Solar-Powered Electric Vehicle Charging Station for Indian Cities. *World Electr. Veh. J.* **2021**, *12*, 132. [CrossRef]
8. Khalfi, J.; Boumaaz, N.; Soulmani, A.; Laadissi, E.M. Box–Jenkins Black-Box Modeling of a Lithium-Ion Battery Cell Based on Automotive Drive Cycle Data. *World Electr. Veh. J.* **2021**, *12*, 102. [CrossRef]

9. Pokharel, S.; Sah, P.; Ganta, D. Improved Prediction of Total Energy Consumption and Feature Analysis in Electric Vehicles Using Machine Learning and Shapley Additive Explanations Method. *World Electr. Veh. J.* **2021**, *12*, 94. [CrossRef]
10. Mckenzie, K.A. Sun, Wind and Waves: EV Fossil Fuel Use and Emissions on an Isolated, Oil-Dependent Hawaiian Island. *World Electr. Veh. J.* **2021**, *12*, 87. [CrossRef]
11. Cao, Y.; Zhang, X.; Liu, X.; Ma, Y. Study on Modulation Strategy of Electronic Converters Based on Improved D-NPC Topology for Full Electric Vehicle. *World Electr. Veh. J.* **2021**, *12*, 80. [CrossRef]
12. Aldosry, A.M.; Zulkifli, R. Heat Transfer Enhancement of Liquid Cooled Copper Plate with Oblique Fins for Electric Vehicles Battery Thermal Management. *World Electr. Veh. J.* **2021**, *12*, 55. [CrossRef]
13. Chandran, V.; Patil, C.K.; Karthick, A.; Ganeshaperumal, D.; Rahim, R.; Ghosh, A. State of Charge Estimation of Lithium-Ion Battery for Electric Vehicles Using Machine Learning Algorithms. *World Electr. Veh. J.* **2021**, *12*, 38. [CrossRef]
14. Kubiczek, J.; Hadasik, B. Segmentation of Passenger Electric Cars Market in Poland. *World Electr. Veh. J.* **2021**, *12*, 23. [CrossRef]
15. Liu, G.; Zhang, L. Research on the Thermal Characteristics of an 18650 Lithium-Ion Battery Based on an Electrochemical–Thermal Flow Coupling Model. *World Electr. Veh. J.* **2021**, *12*, 250. [CrossRef]