Péter Odry [8]
Institute of Information Technology, University of Dunaujvaros/Hungary
Tibor Szakáll [9]
Department of Informatics, Technical College of Applied Sciences, Subotica/Serbia
Zoltán Király [10]
Institute of Information Technology, University of Dunaujvaros/Hungary

THE PAST, PRESENT AND FUTURE OF THE ELECTRIC VEHICLES

DOI: 10.5937/PIM250290

Abstract:
Electric vehicles are developed in parallel in the 19th and early 20th centuries, however at the beginning of the 20th century, due to the energy density of the fuel stored in the vehicle, the competition was decided in favour of internal combustion engines. Currently, at the end of the 20th century, it seems - due to environmentalists - that the competition with lithium technology will be decided in favour of electric vehicles. But what will happen in the future, this is a big question, can they still increase the energy density? New competing solutions are emerging, one of which is very spectacular, the hydrogen technology.

Keywords: *Electric vehicles, Energy, Lithium, Hydrogen*

Introduction

An interesting example can be introduced to symbolize the life cycle of the electric vehicle industry, with the difference that the cycle's initiation occurred earlier in the case of telecommunications than in electric automobilism. When examining the development of telecommunications, the first step was purely digital, as represented by the telegraphy developed by Morse [1]. This solution effectively “digitized” letters, numbers, and various symbols in today's terminology, using two distinct characters. Later, attempts were made by Bell and his colleagues to digitize speech and microphone signals, although many essential elements were lacking, particularly Shannon’s theorem. Consequently, analog technology advanced in the field of telecommunications [2]. With the progress of telecommunications, the increasing complexity of multiplexing,

[8] podry@uniduna.hu, ORCiD: 0000-0003-2395-5259
[9] tibi@vts.su.ac.rs, ORCiD: 0000-0003-0837-4456
[10] kiru@uniduna.hu, ORCiD: 0000-0002-6808-3856

modulation, and encryption requirements made noise an even greater challenge. During World War II, there was a particularly strong demand for communication solutions that could address these issues. The solution was found in the digitization of signals by applying Shannon's principle [3].

Similarly to the development of telecommunications, electric automobilism was in a leading position at the end of the 19th century [4]. However, as automobiles powered by internal combustion engines became more efficient following the invention of the gearbox - particularly in terms of the distance traveled per unit of fuel mass and the range achievable on a single charge - the competition was lost in 1912, especially with the introduction of the Ford Model T. Automobiles equipped with internal combustion engines continued to dominate, and electric vehicles were scarcely developed until research and development efforts were initiated by NASA for lunar and Martian vehicles. However, NASA's research did not directly lead to the advancement of electric automobilism. Two primary factors served as motivating forces in this field: the shiftin environmental policies and the revolutionary advancements in lithium-based battery technology. In modern lithium-based batteries, the ratio of speed per charge to battery weight has shown continuous improvement. Nevertheless, in terms of efficiency and cost, internal combustion engine vehicles still demonstrate significantly better performance. In the case of small vehicles, the efficiency indicators remain particularly unfavorable.

The revolution of hydrogen-powered engines and vehicles is on the horizon. In the case of hydrogen-powered vehicles, the ratio of distance traveled to the hydrogen contained in the tank exhibits significantly better parameters compared to both, conventional internal combustion and electric vehicles. In this field, Toyota has made the most progress (similarly to its early advancements in electric vehicles; it is symptomatic that Toyota has abandoned the field of electric automobilism and does not compete in this sector, opting instead to commercialize its previously researched results) [5].

In the field of electric vehicle technology, two projects have been successfully completed: the implementation of a high-power magnetic charging system [6] and the development of a robot-based automatic electric charging station applicable to any vehicle type [7].

In our view, a new type of hybrid, the hydrogen-electric vehicle, will ultimately emerge as the most successful solution.

Where Can Electric Vehicle Remain Competitive?

Many aspects could be addressed in this paper; however, a topic expected to preserve the competitiveness of electric automobilism has been selected: the issue of the distributed dynamic electric energy storage system. In the future, electric vehicles may become an integral part of the energy infrastructure.

According to a scientific article published in Nature [8], the widespread adoption of electric vehicles is not merely a development in transportation but could become an infrastructural component of the expansion of renewable energy.

The necessity for urgent and more intensive actions against climate change is widely recognized. Solar and wind energy systems are known to generate variable amounts of energy due to their inherent nature, posing significant challenges to power network stability. Meanwhile, with the recent proliferation of electric vehicles, a substantial amount of energy storage capacity is being distributed among individuals. However, by optimizing its utilization, benefits can be achieved for all stakeholders.

The batteries of electric vehicles meet the requirements for short-term energy storage. Not only is the concept of smart bidirectional charging considered for vehicles connected to chargers during the night and daytime, but also the fact that once a battery degrades by 20%, it is no longer suitable for driving. When removed and used in a stationary manner, these batteries can still serve energy demand efficiently.

The previously predicted collapse of the electrical network due to the immense energy demand of electric vehicles has not materialized. On the contrary, with appropriate regulation, electric vehicles are expected to become an integral part of the power network/grid in the future. The storage system thus established will provide backup energy and alleviate stress on the energy network by balancing peak consumption periods.

Electric vehicles connected to charging stations and their onboard storage systems can become part of the electrical grid in two ways with the vehicle-to-grid technology [9]:

- through V1G, peak loads can be optimized to reduce the strain on the grid, thereby improving the efficiency of the electrical system. Thus, this is a one-way energy flow where electric vehicles are charged from the grid.
- alternatively, through the reverse flow of electricity via V2G, the batteries of electric vehicles can participate in various energy markets. Hence, this is a to two-way energy flow, where electric vehicles not only receive energy from the grid but can also supply energy back to it.

The vehicle-to-grid (V2G) and back technology can offer significant advantages in reducing demand on electrical networks, while also enabling electric vehicle owners to use more environmentally friendly and cheaper electricity. One of the key advantages of V2G is that the storage battery is already integrated into the consumer's vehicle, which reduces the need for additional investments.

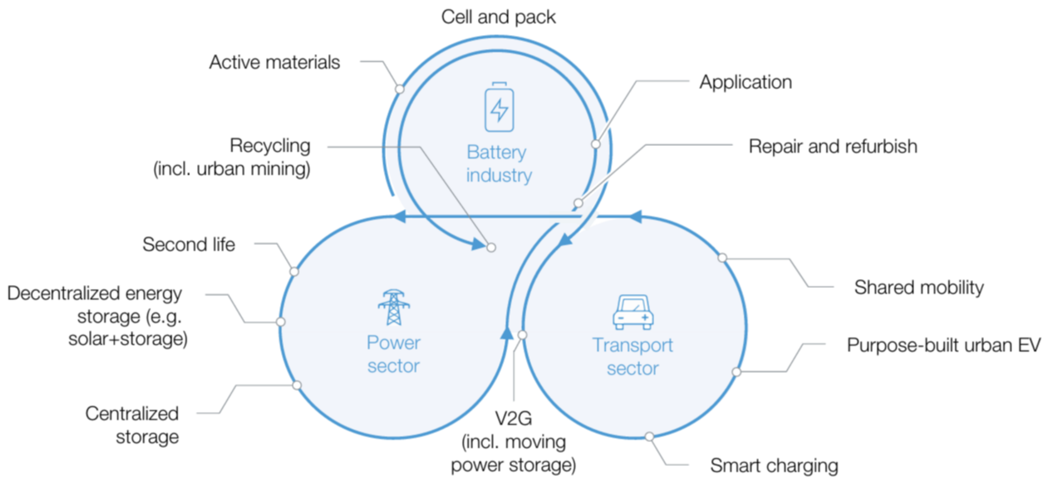

Figure 1. *A world in which electric vehicle batteries are used to power sustainable development [9]*

The above has two system-level impacts:

- By integrating electric vehicles into electrical networks, a revenue source is provided for vehicle owners. This strengthens the business aspect of electric mobility.
- Electric vehicles provide energy storage capacity for electrical networks, enabling the increased integration of intermittent renewable energy into the network.

In the target state, it can be assumed that both the industry and decision-makers will act to realize the benefits of V1G/V2G.

Conclusion

The revolution of electric mobility, driven by artificial intelligence and quantum intelligence, could be a defining moment in the future. The future will be shaped by real-time adaptive, software-defined vehicles integrated into 5G or 6G networks, which will surpass current challenges. The future of unlimited possibilities is being shaped towards a smarter, greener, electrified world.

With the increasing presence of green energy, the green future can only be realized with an increasingly intelligent, distributed source/consumer network, but only if more electric vehicles are integrated into the network.

Acknowledgements

This research was part of the project 2020-1.1.2-PIACI-KFI-2020-00173 of the University of Dunaujavaros.

REFERENCES

[1] https://en.wikipedia.org/wiki/Morse_code

[2] https://en.wikipedia.org/wiki/Alexander_Graham_Bell

[3] https://en.wikipedia.org/wiki/Nyquist%E2%80%93Shannon_sampling_theorem

[4] https://en.wikipedia.org/wiki/Electric_vehicle

[5] https://www.youtube.com/watch?v=191zx30y16M

[6] V. Rajs, D. Herceg, Ž. Despotović, M. Bogdanović, M. Šiljegović, B. Popadić, Z. Kiraly, Z. Vizvari, Z. Sari, M. Klincsik, I. Felde, P. Odry, V. Tadic (2024). Dead-time effect in inverters on wireless power transfer, Electronics 13 (2), 304, DOI: 10.3390/electronics13020304

[7] V. Tadity, A. Odry, Z. Vizvári, Z. Kiraly, I. Felde, P. Odry (2024). Electric vehicle charging socket detection using YOLOv8s model, Acta Polytechnica Hungarica 21 (10), 121-139, DOI: 10.12700/APH.21.10.2024.10.8

[8] C. Xu, P. Behrens, P. Gasper, K. Smith, M. Hu, A. Tukker and B. Steubing (2023). Electric vehicle batteries alone could satisfy short-term grid storage demand by as early as 2030", Nature Communications volume 14, Article number: 119, DOI: 10.1038/s41467-022-35393-0

[9] A Vision for a Sustainable Battery Value Chain in 2030 Unlocking the Full Potential to Power Sustainable Development and Climate Change Mitigation (2019). World Economic Forum, Global Battery Alliance; McKinsey and SYSTEMIQ analysis, https://www.globalbattery.org/media/publications/WEF_A_Vision_for_a_Sustainable_Battery_Value_Chain_in_2030_Report.pdf .