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COMPARISON OF BATTERY ELECTRIC VEHICLE AND HYBRID ELECTRIC VEHICLE

The topic of electric vehicles is popular nowadays, as electric vehicles, during their exploitation, leave less emission compared to internal combustion engine vehicles. Thus, according to [1], if in 2020, electric vehicle sales were only 4%, in 2022, this value has skyrocketed to 14%. The term “electric vehicle” (EV) generally refers to a vehicle that is driven by an electric motor powered by a self-contained power source. In this article we will discuss about two varieties of electric vehicles: Battery EV (BEV) and Plug-In Hybrid EV (PHEV). Look at their positive and negative sides, from the point of view of an ordinary user and make a definite conclusion on this basis.

1) Battery Electric Vehicle (BEV)

The main source of energy and the most expensive element in BEVs is the battery [2]. These vehicles are powered solely by batteries which can be charged using Level 1, 2, or 3 chargers. There are differences between each charging level. However, as a general rule, the higher the Level, the higher the power output from the charger and the faster it can charge [3]. Home charging can be done with Level 1 or Level 2 chargers, while Level 3 chargers are meant for special charging stations. Nowadays, lithium-ion batteries, which have the highest energy density, are the most widely used batteries in electric vehicles. If we compare BEVs to PHEVs, we will be able to highlight such advantages and disadvantages of BEV [4]:

- **Advantages:** The powertrain design of a BEV is simple and cost-effective, as the power from the battery is directly transmitted to the motor(s) attached to the axle(s). Larger batteries, compared to hybrids, offer an extended all-electric range. Zero tailpipe emissions. Low operating expenses. Simplicity in repair and maintenance compared to PHEVs.
- **Disadvantages:** BEVs need to be plugged in to charge, and the process may take considerable time. Planning for charging is required for extended trips. The initial price of a BEV may be higher compared to other EVs, especially if it has a greater range.

2) Plug-In Hybrid EV (PHEV)

Plug-in Hybrid Electric Vehicles (PHEVs) are advanced hybrids that use a combination of an electric motor and an internal combustion engine for power. Plug-in hybrids (hybrid plugins) are divided into several types [5]:

- **Parallel** — they combine the operation of electric and gasoline engines and allow the battery to be charged from the network;
- **Series (REEV/REX)** — EVs with an increased range. In this type of hybrid, the car is always powered by an electric motor that is powered directly from the battery, but the battery itself is charged while driving by the built-in fuel generator;
- **Series-parallel** — capable of operating as both serial and parallel hybrid vehicles with an electric motor as the main drive;
- **Fuel cell vehicles (FCV)**, which include an electrochemical generator to convert hydrogen, which stored in special hydrogen tanks (similar to the fuel tanks in regular cars) into electrical energy.

If we compare different types of PHEVs to BEVs, we will be able to make such conclusions about their positive and negative aspects:

- Advantages of PHEVs: The presence of two different types of engines provides versatility in the choice of fuel type, which in turn allows you to select different stations for energy refueling. Long running range and fast energy refueling compared to BEVs.
- Disadvantages: High prices for hydrogen. Big weight, due to the presence of two engines, that negatively impacting to performance and fuel efficiency. Emissions from hybrid vehicles still contribute to air pollution. Complicated repair and maintenance.

On the basis of the data presented in this article, we can reach the following conclusion: Plug-in Hybrid Electric Vehicles (PHEVs) are a better choice than Battery EVs (BEVs) as they have such important characteristics: long travel range, fast refueling, versatility in the choice of fuel type. Until BEVs cannot improve the first two important characteristics mentioned earlier, they are uncompetitive with PHEVs, outside the city limits, or if there is a need to use an electric vehicle for long periods of time in the city (e.g. to work as a cab driver). Potential solutions for such problems could be: development and expansion of networks of charging stations for electric vehicles, improved battery performance of EVs, or the use of battery swapping technology, similar to how scooter batteries are swapped in Asian countries [6].

References:

1. International Energy Agency, URL: <https://www.iea.org/energy-system/transport/electric-vehicles> (Accessed: Nov 14, 2023).
2. “Evesco” company site, URL: <https://www.power-sonic.com/blog/levels-of-ev-charging/#:~:text=There%20are%20three%20EV%20charging,the%20faster%20it%20can%20charge> (Accessed: Nov 16, 2023).
3. “KnaufIndustries” company site, URL: <https://knaufautomotive.com/ru/vid-elektromobiley-i-razvitiye-sektora/> (Accessed: Nov 15, 2023).
4. MUO (online technology publications): EV Powertrains and Their Differences Explained Simply, URL: <https://www.makeuseof.com/exploring-differences-ev-powertrains/> (Accessed: Nov 15, 2023).
5. MDPI (Open Science Journal): Mathematical Modeling the Performance of an Electric Vehicle Considering Various Driving Cycles; URL: <https://www.mdpi.com/2227-7390/11/11/2586> (Accessed: Nov 15, 2023).
6. “Solution 1” company site, URL: <https://solution1.com.tw/green-solution-battery-swapping-services-for-electric-scooters-gaining-popularity-in-asia/> (Accessed: Nov 16, 2023).