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Whiz, Not Bang: Electric Vehicle Technology

By Philip Barnes and Jorge Hernandez-Limon, May 2021

Newer technology vehicles—electric vehicles (EVs), plug-in hybrid electric vehicles, and hybrid electric vehicles—are breaking sales records every year in Delaware. Local governments should support this growing market by adopting enabling policies and installing charging infrastructure. First, however, it is important to understand how this new technology differs from standard petrol- and diesel-powered vehicles with an internal combustion engine (ICE). ICE vehicles ignite liquid fuel and channel the energy through a series of physical mechanism to propel the vehicle. The tailpipe then discards the exhaust from that combustion process, releasing gases into the air.[1]

ELECTRIC VEHICLE TECHNOLOGY

Instead of a fuel tank and internal combustion engine, fully electric vehicles are powered by a charged battery pack and an electric motor. The electric motor receives an electric current from the battery and provides force to the drivetrain. There are no sparkplugs, no ignition of fuels, no pistons, no motor oil, and no exhaust system. Because the electric motor in an EV supplies torque directly to the drivetrain, there is no geared transmission, either manual or automatic.[2]

Instead of filling a fuel tank at a gas station, EV batteries are charged through the electric grid, either at home, work, or any number of chargers in the network. Batteries are also recharged through regenerative braking where energy is recovered during deceleration.

PLUG-IN HYBRID AND HYBRID

Plug-in hybrid electric vehicles (PHEVs) effectively contain the propulsion systems of both EVs and standard vehicles: They have a battery pack with an electric motor, as well as a fuel tank and internal combustion engine. PHEVs can run in electric mode until the battery is depleted, then switch over to petrol or diesel to power the vehicle through the ICE. The battery in a PHEV is charged like an EV, by plugging in to the electric grid (hence the name plug-in hybrid) as well as regenerative braking.

A hybrid electric vehicle (HEV), by contrast, is like a PHEV but it cannot be plugged in to charge the battery. The battery and electric motor in an HEV are used to supplement the power output of the ICE, providing greater fuel efficiency in the process. Batteries in an HEV are only recharged by the ICE and regenerative braking.[3]

VEHICLE RANGE AND CHARGING

With optimal conditions, most new EVs have 200+ miles of range, with the upcoming Tesla Model S Plaid expected to top 500 miles.[4] That range compares favorably to ICE-only vehicles with a standard 16-gallon tank and 30 miles per gallon fuel economy. It is estimated that in the next five years, the average EV will be able to travel 400 miles on a single charge, competing with most ICE models.[5] The smaller battery packs of PHEVs typically provide 25–35 miles of range in all-electric mode. For context, the average American drives 29 miles per day, making the electric propulsion systems in PHEVs capable of meeting most needs.[6]

A notable difference between ICE vehicles and EVs is how temperature affects vehicle range, as cold and hot weather is known to decrease the efficiency of both ICEs and EVs. In city driving, the fuel economy of petrol and diesel-powered vehicles at 20° F is reduced by 24% compared to 77° F. Likewise, EVs and PHEVs typically see larger reductions in the 30–40% range.[7] This larger drop in range for EVs is largely due to increased demand on the battery to heat the vehicle cabin. Range also drops as outdoor temperatures increase above 80° F because the cabin will likely need to be air conditioned.

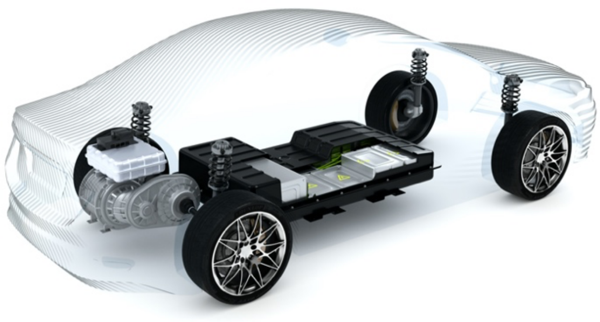
"Range anxiety" is a barrier to greater EV adoption as potential owners worry about depleting their battery before finding the next charging station. Indeed, there is room for significant expansion of charging infrastructure in the United States.[8] The Biden Administration's proposed EV investments include $15 billion to install an additional half million charging stations across the US by 2030.[9]

In terms of charging speed, the fastest charging option, "Level III," uses direct current and can supply 270 miles of range in 30 minutes. "Level II" chargers use a 240 volt alternating current (like a clothes dryer) and provide about 60 miles of range per hour. The slowest option, "Level I," uses a standard 120 volt outlet and offer 6 miles of range per hour charged.[10] Improving charging speed is a significant focus of research efforts, with promising technologies demonstrating the ability to fully charge a battery in ten minutes.[11] This would make EV charging comparable to the convenience and efficiency of filling up a fuel tank.

COSTS OF OWNERSHIP

Cost is perhaps the most important criteria people apply when purchasing a new vehicle. EV and PHEV models do have higher sticker prices than their ICE counterparts, but simply comparing the initial price would be misleading. There are combined federal and State of Delaware incentives of $10,000 for purchasing EVs, and there are additional cost savings over the life of the vehicle.

EVs have lower maintenance costs due to their more straightforward design and fewer moving parts. Not having an ICE eliminates the need for oil changes and tune-ups, along with other issues like leaky head gaskets or exhaust systems. Brake pads do not need to be replaced as frequently in EVs as regenerative braking eases some of the load.[12]



Per mile, it is cheaper to drive on electricity than petrol or diesel. Electricity prices are relatively inexpensive in Delaware, and residents could save more than $11,000 in fuel costs over the life of an EV.[13] Delmarva Power customers can reduce costs further by taking advantage of a special reduced rate for off-peak EV charging.[14] Between the purchasing incentives, lower maintenance costs, and fuel savings, EVs are a cost-competitive transportation option.

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[1] US Department of Energy, 2020b
[2] US Department of Energy, 2020a
[3] US Department of Energy, 2020c
[4] Gold, 2021
[5] McDonald, 2018
[6] US Department of Transportation, 2017
[7] Lohse-Busch et al., 2013
[8] Mims, 2021
[9] The White House, 2021
[10] Hamon, 2018
[11] Yang, Liu, and Wang, 2021
[12] Preston, 2020
[13] Borlaug et al., 2020
[14] Delmarva Power, 2021