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Does this car make me look heavy?

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ELECTRIC VEHICLES

- >> The Advantage is the Efficient Motor
- >> The Problem is the Battery Weight
- >> Implications for Energy and Aftermarket

Electric Motors are Efficient

Electric motors have advantages compared to internal combustion engines. They have greater torque at lower speed, they are easily configured for regenerative power technologies (like braking), and they are more efficient users of power.

Electric motors are more than twice as energy efficient as internal combustion engines, meaning they produce twice as much motion for every unit of fuel. The calculations have a few steps here, but they line up this way. Internal combustion engines are about 35% efficient. For a typical internal combustion engine alone, one unit of fuel yields 0.35 units of power. Internal combustion engines, however don't function independent of infrastructure support. Energy required for storage and delivery systems for fuels removes about half of an engines fuel conversion efficiency, -17%. On the other hand, electric motors are over 90% efficient. Their comparative advantage is eroded a bit by storage (about 15% of energy is lost in battery charging), transmission (4% of electrical power is lost in transmission lines, and by production (combined cycle power plants turn 40-60% of input into power). These collateral losses make electric motors 37% net efficient (90% * (1-15%) * (1-4%)* 50%). 37% efficient electric motor processes are more than twice as efficient as 17% efficient internal combustion engines.

Electric motors are gaining share in transportation markets, albeit from a very small base. If electric motors continue to advance on internal combustion engines, one of the outcomes will be a reduction in petroleum use. A 15 gallon tank-full of gasoline can power an average vehicle for 400 miles. In electric power terms, each gallon yields 33.41kwh of energy per gallon (Alternative Fuels Data Center), for a total of 501kwh used to go 400 miles. On a per mile basis, the energy used by our sample internal combustion engine is 1.25kwh per mile. Comparatively, representative electric vehicles use a full 60kwh battery pack to travel 250 miles, 0.24kwh of energy used per mile. Both of these figures represent efficiency once the power resides on a vehicle. Adjusting numbers for the supply chains described above, an average internal combustion powered vehicle uses 2.5kwh of energy per mile while a representative EV uses 0.56kwh of energy per mile.

Petroleum Demand is Falling

According to *InsideEVs*, there were 199,826 battery powered automobiles sold in the US in 2017. CNN estimates that sum to be 1.5% of all US cars produced. Average miles per vehicle driven in the US nears 12,000 per year, so the EV's sold in 2017 would be expected to travel 2.4 million miles in the year ahead. If each of those 2.4 million miles travelled uses 1.94kwh's less energy than that consumed by the vehicles the EV's replaced (2.50 – 0.56), then the country will consume 4.7 million fewer kilowatt hours of energy this year. While that sounds like a lot, such a reduction in power consumption would represent a decline of 0.04% of the energy consumed in the US in 2017. As it relates to petroleum use, the reduction would be higher as 61% of electric power is petroleum-based compared to about 90% of gasoline content, adjusting for ethanol and other chemical additives. At current production rates, an additional 320,000 EV's will hit the road in the US during 2018 (1.9% market share), and as those numbers grow, the decline in overall petroleum use accumulates. Fiat Chrysler's Sergio Marchionne predicts that "fewer than half the cars sold will be fully combustion powered" by 2025 (Bloomberg 1/15/18). That statement doesn't distinguish between fully electric and hybrid cars, but Ford provided some insight into that mix at the Detroit Auto Show saying 22 of their 40 planned EV's will be fully electric, 55%. Annual US auto production is near 17 million units, and Fiat and Ford estimates suggest that the industry is on a path to annual production of five million EV's per year over the next seven years. On that trajectory, all else equal, US power consumption will decline by 2% on an annual rate by then.

According to *Green Car Reports*, usage of public charging stations has grown each year since the first modern EV was released.

EV Weight is Preventing Mass Adoption

Despite the energy efficiency of the vehicles, a host of factors have kept EV's from meeting previous sales projections. The status of the tax incentive ($7,500) in the US was in question for much of 2017, and the industry experienced sourcing issues, especially in lithium, a critical component for EV batteries. The issue retarding growth that may not be addressed near term is weight. A battery pack aboard an EV weighs over 1,000 pounds. While there are offsets to this weight, for example a transmission, which is not necessary on an EV, weighs over 200 pounds on average. Gas tanks, oil reservoirs, and catalytic converters are also not necessary parts for a fully electric vehicle. Those have a combined weight of about 150 pounds. So, while there are offsets, EV's weigh about 650 pounds more than combustion-powered vehicles. That additional weight seems to be an impediment to the vehicles both achieving customer desired range and to safety ratings. Improvements in battery density, some already achieved by Tesla's Gigafactory, are expected to reduce battery weight by 10% or more over the coming years. While that's probably not sufficient to solve the weight issue, such progress would encourage the current scientific thinking that a 50% reduction in ultimate EV battery weight is possible. Sony says they have developed a lithium-sulfur battery that is 40% more energy dense. It is expected to be available as soon as 2020. These scientific achievements becoming production ready seems necessary for EV's to achieve industry forecasts.

Demand for Maintenance Threatened

Some further improvement in battery density may be enough to enhance the attractiveness of EV's to US consumers. The electric motor, along with being more efficient, requires less maintenance. In our opinion, consumers would perceive some value from having no oil changes, no tune-ups, no spark plugs, no transmission maintenance, and more uptime. Brakes on an EV are often regenerative, and as such, they last twice as long as conventional brakes. A larger EV fleet is bad news for auto parts OEM's and retailers, oil change operations, filter manufacturers, as well as auto dealers who are sensitive to their parts and maintenance divisions. They see it coming, yet it fortifies their position to expect a slow adoption. In January 2018, Autozone's CEO said he is preparing for EV's to represent 20% of vehicle sales by 2030. While tires, windshield wipers, and other wear parts may be okay, EV's appear to be a net negative for auto parts and maintenance businesses.

Conclusion

Through both lower energy use and reduced maintenance, the advantages of an electric motor over an internal combustion engine are evident. However, battery weight is slowing adoption of the EV platform. JAG's investment research will focus on developments in the battery area. If EV's ultimately become a material part of the US auto mix, demand for energy and aftermarket services would fall. We think a successful, long term EV investment strategy would be skeptical of energy and aftermarket holdings.

ABOUT JAG

JAG Capital Management is an independent, 100% employee-owned registered investment advisor headquartered in St. Louis, Missouri. The firm provides portfolio management services for institutions, individuals, investment advisory firms and corporations. In addition to managing the JAG Large Cap Growth mutual fund, equity and fixed income separate accounts are also offered.

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