A History & Study of Electric Vehicles: Inconvenient Truth About Electric Vehicles

A History of Electric Vehicle

- Thomas Edison originally convinced Henry Ford that all of his cars should be powered by electricity, and Ford seriously considered following his fried Edison's advice
- Because of pollution fears, and worries surrounding long-term supplies of petroleum, cars powered by the internal combustion engine (ICE) had not yet come to dominate the passenger car market
- 28% of all cars produced in the US at the time were electric, and in the heavily populated US east coast, approximately 1/3 of all cars on the road were powered with electricity
- Ford recognized the superior economics of the ICE, and the end result was his decision to produce not the EV, but the Model T
- After his initial setback with Ford, Edison realized that a rapid advance in battery technology was necessary
- In 1904, Edison announced a huge breakthrough: the nickel-iron-alkaline battery, although it would take him another five years to perfect its reliability
- With his battery's 45% increase in energy density, in 1914, Edison convinced Henry Ford to pursue the idea of the "Ford Electric", an EV with a 100-mile range and retail price of $900 (about twice the price of a Model T at the time)
- Ford Electric's range and high cost left it uncompetitive versus the Model T; the "Ford Electric" was never built
- In 1912, the EV lost one of its last competitive advantages: the electric starter had been invented; cars with ICE no longer had to be started by hand-cranking; the EV literally disappeared into obscurity for the next 50 years

- One of the strongest convictions held by investors today is that EVs will come to dominate passenger vehicle sales in the coming decades. We are constantly told that since the attributes of the EV are so compelling, it will be only fifteen years before they almost completely displace the ICE from the road
- For example, on our last investment trip to India and Pakistan, everyone we met with wanted to discuss EVs and their negative impact on global oil demand. The potential adoption of EVs as a “disruptive technology” has turned thinking in the energy industry upside down
- 15 years ago, one of the more prominent debates in global oil markets was “peak oil”. Today however, with the potential domination of the passenger vehicle market by EVs, everyone is asking when, not if, global oil demand will peak and then decline
- But there are problems with the adoption of the EV that we believe are critically important, and which are greatly misunderstood by investors
- Although battery technology continues its relentless move forward, the basic problem surrounding the EV has not changed since Edison and Ford confronted it 100 years ago. We believe EVs remain uncompetitive versus the ICE car. Unless there is a massive breakthrough in storage technology, the electric car can’t compete against the ICE unless oil prices rise significantly
- If oil prices remain at today’s levels, governments who wish to significantly increase the penetration of EV sales will have to either massively subsidize their purchase or else discourage the purchase of ICE cars
- Already, we have numerous examples of generous subsidies put in place to encourage purchases of EVs. In each of these examples, either the subsidies were perceived to be unfair or else the loss of government revenue became too great and eventually the subsidies were either removed or severely reduced

        - What happened to EV sales when these subsidies were removed? EV sales in Hong Kong, the State of Georgia, and Denmark declined by 100%, 90%, and 80% respectively
- Climate-change debate adds a whole new level of complexity when talking about renewable energy and EVs. It's still unclear if the introduction of EVs will reduce a country's level of CO2 emissions
- Norway's oil consumption continues to grow despite surging EV sales. Although EV sales are high, it is unclear how much Norwegians are actually driving them. Data seems to indicate that Norwegians continue to use their ICE cars for much of their driving needs and are simply keeping their EVs in the garage, except when needed to avoid paying bridge and highway tolls – EVs are exempt. This would explain why Norwegian oil demand continues to grow despite rising EV sales and is another data point highlighting the high cost of EV ownership, even with extensive subsidies

<u>The "Energetics" of EVs</u>

- If it's true that sometime soon the efficiencies of that EV will become equal to the ICE vehicle, then consumers will gladly trade in their old cars for the new EVs without hesitation
- However, what if the efficiencies of today EVs are still so far behind the ICE, that even assuming big increase in battery technology, they will never be competitive against the ICE?
- Energy is the only currency: one of its many forms must be transformed to get anything done. The adoption of major technologies throughout time all resulted in a more efficient conversion of energy generated from the increased harvest was less than the energy required to raise, house and feed the horse. It was not until improved harnesses were introduced that the "energy return on energy invested" (EROEI) swung positive and farming practices changed

- Despite all the recent and significant advancements in technology, an EV is simply not as efficient as an ICE. Unless subsidized or forced by legislation, the widespread adoption of EVs therefore remains problematic and highly uncertain

Battery Manufacturing

- Analysts talk about the declining cost of lithium-ion batteries and many investors simply assume these trends will continue forever
- However, there is reason to think that much of this improvement was one-time in nature
- Energy consumed in battery manufacturing can be put in two categories: energy needed for the raw materials and energy needed for the manufacturing of the battery
- Over the last 5 years, the bulk of energy savings have come from the manufacturing stage. The so-called “dry rooms” use a tremendous amount of energy to heat and dry the slurry making up the cathode and anode of the battery cell. As these facilities have increased their utilization, the energy necessary to dry one unit has come down considerably
- Most large-scale facilities are now operating near or at their productive capacity and future energy savings will be incremental from here

Recharge Cycle Life

- Extending the life of batteries would help the equation
- Lithium-ion batteries can be very finicky and require a stable operating environment in order to age properly
- If the climate is too hot or too cold, the life of the battery is irreparably damaged
- Much of the new proposed battery chemistry is even more sensitive to environmental stresses than the existing batteries and so not ideally suited for use in EVs

- Quickly recharging and discharging the battery has been shown to impair battery longevity
- To that end, “ultra-capacitors” can be used to provide short bursts of power to the drive-train and remove stress from the battery. However, these themselves require energy to produce and to a certain extent are already included in today’s EV calculations

PV Solar & Improving Efficiency of ICEs

- There has been much discussion about the declining cost of PV solar modules over the last 7 years
- However, a closer analysis reveals that a large contributor to this was the reversal of a price increase in polysilicon in 2010 due to an industry-wide supply shortage
- The shortage proved to be temporary and prices declined by as much as 75% and so in turn has the cost to produce a PV module
- On the other hand, there is reason to believe that the energy efficiency of ICEs will continue to improve
- Mazda announced a new engine technology that is expected to improve efficiency by 20%
- Diesel vehicles commonly achieve 20%-35% greater mileage than gasoline engines while the energy contained in a gallon of diesel is only 10 to 15% higher. Up to 80% of the energy content of a gallon of gasoline is lost in an ICE, leaving ample room for future efficiency gains
- One prediction: the EV will eventually win out over the ICE based on its energy efficiency, but not the way most people expect. Once we have depleted our readily available sources of efficient crude, the EROEI of oil production will deteriorate to the point that EVs become more efficient. In fact, if you look at the least efficient marginal sources of crude oil today, the EROEI is close to 5:1. If that was the only remaining source of oil, then it would indeed be more efficient to run an EV fleet.

However, were that the only remaining source of global oil, the price would be multiples of where it is today not “worthless” as the EV proponents argue

- Over a century ago, EVs lost their battle against the ICE, as consumers quickly realized the operating and cost efficiency of the latter. Although few have done the work, we believe the EV energy efficiency still lags the ICE just like it did when both Edison and Ford tried to make an EV that could compete with the ICE
- We believe EV sales will increase as we progress into the coming decade; however, the costs when combined with investments in renewable sources needed for CO2 reduction are going to be extremely expensive and will have to be borne by governments through subsidies or by consumers through legislation. Given how costly and painful the process could become, we believe we are overestimating the potential penetration of EVs in the global transportation market, and their ultimate impact on global oil consumption

Goehring & Rozencwajg 1Q18 Letter

Image Source: Common Sense Evaluation