Electric Vehicles: A Disruptive Game Changer?

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A. Some History

The history of electrified transportation, as reported by reliable sources [1] begins in mid 1830's Europe, where autodidactic individuals mechanize various forms of agricultural transport. A noted British inventor, Robert Anderson, develops the first crude electrified carriage at this time. Other European inventors, notably in Hungary and the Netherlands, follow in Anderson's path.

Progress is then somewhat slow until later in the 19th century when William Morrison, a chemist from Des Moines, Iowa, develops a six passenger vehicle that could reach a top speed of 14 miles per hour. Ferdinand Porsche develops his first electrified vehicle, the P1, in 1898. During the early days of 1900, electric cars were very popular. They were quiet, easy to drive, and did not require a manual crank to start. However, that situation began to change, in 1912, with the introduction of Ford's Model T and Kettering's electric starter. The popularity of gasoline powered transportation remained strong for the next fifty years.

The world began to change after World War II. Global geopolitical affairs, wars, resource shortages, and unstable governments, created an oscillating landscape for fuel price and availability. The first panic, in the mid 1970's compelled the U.S. Congress to introduce **H.R. 8800 Electric and Hybrid Vehicle Research, Development,**

and Demonstration Act of 1976. A second economic crisis, some comparing that to the **Great Depression** of the 1930's, occurred in 2008. This second crisis compelled the U.S. Congress to introduce the **American Recovery and Reinvestment Act of 2009.** These periods of instability created opportunity for the renewal of the electric car industry. Toyota introduced the Prius in 1997. A fledgling start-up in Silicon Valley, Tesla Motors, introduced their electric vehicle in 2006. Both the Chevy Volt and Nissan Leaf were introduced in 2010.

Over the last ten years with President Obama's **Everywhere Grand Challenge**, the electric vehicle ecosystem has continued to grow. Much of this growth has emerged from concerns over climate change, the domestic availability of hydrocarbon fuels, the perceived technology advancements around electric vehicles displacing jobs in the traditional automobile supply chain, and further geopolitical instability. And the instability in Eastern Europe has driven prices even higher.

The U.S. Congress continues to grapple with legislation that will further shift the "transportation mix" towards electrification, including measures to increase charging infrastructure. This will all sort itself out as parties agree to compromise. However, compromise they will. And, although the adoption of electric vehicles may continue to experience a somewhat bumpy ride, the automotive industry has certainly gone "all in" with the retooling of its manufacturing facilities to accommodate electric vehicles.

B. The Mandate for Electrified Transportation

As noted previously, in recent history, the first

substantive piece of legislation, associated with electric vehicles, to reach the President's desk for signature was introduced by the 94th Congress: **H.R. 8800, Electric and Hybrid Vehicle Research, Development, and Demonstration Act of 1976**. [2] This was followed by 101st Congress's **S.R. 1630, 1990 Clean Air Act Amendments** [3] and the 102nd Congress's **H.R. 776, 1992 Energy Policy Act** [4]. Much of this legislation was motivated by increasing energy volatility and its impact on the U.S. consumer. The U.S. recession experienced in 2008 motivated the 111th Congress to introduce **H.R. 1, American Recovery and Reinvestment Act of 2009** [5]. And while the 2009 legislation contained some provisions for electrified transportation, its omnibus nature focused more broadly on the entire U.S. economy.

Most recently, the U.S. Congress, principally motivated by domestic economic and global climate concerns, has struggled to move legislation forward into law. President Biden's Build Back Better initiative, introduced into the 117th Congress. as **H.R. 5376**, was adopted by the House of Representatives but was not adopted by the U.S. Senate [6]. In parallel, Senators **Merkley and Cortez-Masto**, of the 117th Congress, have introduced **S.R. 395, Electric CARS Act of 2021** [7] and **S.R 504, Green Spaces, Green Vehicles Act of 2021** [8]. Both have been read twice and referred to committee.

Although the current legislative environment is somewhat ill-defined, the prospect for additional U.S. Congressional support for the electric vehicle industry remains strong. Many congressional districts are located in areas that previously relied on the automotive manufacturing sector. Given that there is significant industrial re-investment in both electric vehicle manufacturing and the establishment of infrastructure, congressional representatives are sure to support the

growth of this new industry in their districts.

C. Operational Performance: Pros and Cons

Idaho National Laboratories provides extensive comparative data detailing the various differences between gasoline and electric powered vehicles [9]. However, in general, the pros and cons of electric vehicles over gasoline powered vehicles may be summarized briefly as follows:

Pros:

- An electric vehicle has one principal moving part, the electric motor. Gasoline vehicles have hundreds of moving, and associated parts: pumps, filters, gaskets. This leads to higher reliability for electric vehicles and lower maintenance costs
- An electric vehicle's maintenance requirements are smaller in number. The electric vehicle may have only two or three items that require periodic inspection. A gasoline powered vehicle will have 10 to 30 items that require periodic inspection.
- An electric vehicle is more energy efficient. Idaho National Laboratory reports that, at 7 cents/kwh, an electric vehicle will travel approximately 40 miles/dollar. In contrast, a gasoline powered vehicle, with an efficiency of 30 mpg and a fuel price of $4.00/gallon, will travel approximately $7.5 miles/dollar.

Cons:

- An electric vehicle has limited range. Although improving with newer models, an electric vehicle may travel approximately 200 miles between charge. A gasoline powered vehicle may travel 400 miles between refueling.
- Electric vehicle recharging infrastructure may be limited in some areas. Although rapidly evolving,

this infrastructure may be sparse in certain rural areas of the country.

- Service availability for electric vehicles may be limited in some areas. Although electric vehicle manufacturers continue to field qualified staff, either through institutional or on site training, qualified service personnel may not be available in all areas.

Despite the current limitations currently existing with electric vehicle ownership, industry is responding aggressively to mitigate user inconvenience. Federal and state governments are appropriating funds and implementing roll out strategies to provide robust recharging infrastructure. Electric vehicle manufacturers, in cooperation with various local and state education administrations, are aggressively fielding qualified service staff. And continuing battery technology and recharging methodology advancements are increasing range capabilities.

Again, given the momentum already established within the electric vehicle industry, the challenges which will inevitably be encountered shall be mitigated with appropriate resource allocation and planning.

D. The Fundamental Value Proposition

In its 2019 report, **Electric Vehicles: Setting a Course for 2030** [10] Deloitte predicts a global compound annual growth rate (CAGR) in electric vehicle sales of 29 percent over the ten year period ending in 2030. Total EV sales were predicted to be 2.5 million in 2020, 11.2 million by 2025, and 31.1 million by 2030. This solid growth in sales will continue to justify future

investment in battery research; product development; safety legislation; logistics and supply chain management; and education and training.

For the individual consumer, technology investment will further mitigate the limiting issues currently experienced. New battery technologies and new, novel, charging methodologies, including full battery replacement at a recharging station, will inevitably enter the market, mitigating both range and charging infrastructure limitations. Well qualified service personnel will continue to enter the workforce. Finally, the economic returns provided by the electric vehicle industry will certainly motivate the U.S. Congress to further support the introduction and adoption of electric vehicles into the nation's transportation infrastructure.

Are electric vehicles a disruptive game changer? The evidence suggests a response in the affirmative. There is sufficient motivation across all vectors of the value proposition calculus to maintain the momentum towards a more electrified fleet.

Indeed, there will be technology bumps in the road and there will be ebbs and flows in the trajectory of the technology's adoption. However, in the long term, electrified transportation provides an efficient, clean economic alternative to all other modes of transportation. And this is an option that surely will not be neglected by tomorrow's society.

References

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