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Key Barriers to the Profitable Commercialization of Plug-in Hybrid and Electric Vehicles

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Electric and Plug-in hybrid electric power train is an expanding technology in the contemporary automotive industry. The concept of the electric vehicle has been deliberated by automakers since the early 20th century; however, the technology hasn't developed significantly enough to be considered a conventional means of transportation, with the exception of golf carts, airport transportation trolleys and similar applications.

Continued research and development has led to the emergence of the new generation of vehicles seen in the past two decades. These vehicles have emerged as a substitute for mainstream transportation and as a potential solution to address the climatic changes, reducing the Green House Gas Emission (GHGE) with nominal dependency on fossil fuels.

Classification of the hybrid or electric power train vehicles is based on the type of power train implemented by the Automotive OEM (Original Equipment Manufacturer). The popular terminology for categorization is Hybrid Electric Vehicles (HEVs), Plug-In Hybrid Electric Vehicles (PHEVs), plug-in Electric Vehicles (EVs), Battery Electric Vehicles (BEVs) and the Fuel Cell Vehicles (FCVs). Various options based on these conceptual power trains from all major OEMs are now available in the market. However, time has not come yet that any automotive OEM can claim the hybrid and electric vehicles as a substitute to gasoline/diesel vehicles.

According to Market Dynamics [1] the number of PEV sales in the United States through August 2013 has surpassed the total 2012 PEV sales. The most popular PEVs include Toyota Prius, Chevy Volt, Nissan LEAF, and Tesla Model S. Ford Focus Electric and Fiat 500 BEV are among the competition as well. However, when compared to sales of conventional gasoline cars, the percentage ratio has fallen for the same period of 2012. In the last decade, the hybrid-electric vehicles did not gain this popularity when automotive OEMs launched HEVs into the market. As of today, more than 129,500 Americans are driving plug-in electric vehicles manufactured by all major automotive OEMs. Regardless of the PEV's hype, U.S. automotive OEMs are still not posting a marginal profit in PEVs and PHEVs sale.

As the automotive researcher and engineers are applying their intellects to further enhance the plug-in hybrid and electric power train technology, automotive sales and market teams are also facing hurdles in convincing consumers to adopt these vehicles as the better mode of transportation. With plentiful options available from Japanese, American and European OEMs and the increased public consumer awareness of the plug-in hybrid-electric technology, the consumer opinion is changing, resulting in both positive and negative opinions. According to an annual survey reported in Electric Vehicle Consumer Survey [2] the consumer excitement towards the new generation of PHEVs and EVs is settling down. As stated in this survey, 40% of the survey participants have shown higher interest in 2011 in purchasing the EVs and PHEVs and the same level of consideration has fallen to 36% in 2012.

The comparatively higher sales price of PHEVs and EVs is definitely an obstacle in convincing consumers to forsake the low cost gasoline vehicles. This challenge could be compounded by introduction of U.S. legislation to cancel the $7,500 plug-in vehicle tax credit.

However, for a consumer, the primary investment in purchasing is not the only drawback. The customer may be initially convinced at the time of purchase that the extra cost of the vehicle (due to high voltage battery) will be offset by the saving of gasoline costs over the next 3-5 years. However, there is an added futuristic hidden investment of the replacement of the high voltage battery. Further, in conjunction with Automotive OEMs, USABC (United States Advanced Battery Consortium) is still working on the development of an optimum procedure for the recycling of high voltage batteries after they are discarded at the dealership. As the high voltage battery technology matures and turns into a commodity, these challenges will eventually fade out.

In addition, PHEVs and PEVs require the installation of a home charging station for a fast charging (240V, level 2 charging) option, otherwise, a complete charge from the conventional 120V outlet will take more than a winter's night duration. Moreover, the $1000 U.S. federal tax credit for purchase and installation of a home charging station has been discontinued. Although the technology is quite mature and the various utility suppliers in many states are now advertising subsidized rates, there is an inherent fear of the risk of fire which could potentially be caused by the charging of high voltage batteries at home.

Another concern which may be raised is for pedestrians being unaware of approaching PHEVs or PEVs due to minimal sound emission.

In a recent survey [3] of 2,500 U.S. car owners regarding their preference of the choice of the vehicle, more than 75% stated a PEV would fulfill their daily transportation needs. However, most of them expressed anxiety regarding range limitations. More than 25% of the consumers surveyed would prefer owning a HEV or a PHEV, and only 5.5% portray eagerness to own a PEV as the principal means of their daily transportation.

Along with other factors, range estimation is based on the state of the charge (SOC) and state of the health (SOH) of the of the high voltage battery. The same way as an aging cell phone battery dies quicker than when it was new, the SOH of the high voltage batteries deteriorate over

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time as well, due to chemical aging. The performance fading of the high voltage battery depends on the vehicle usage pattern as well as exposure to extreme weather conditions. However, the range estimation in commercially available vehicles is quite accurate and there are enough warnings on the state of the art Instrument Panel Clusters (IPC) and Human Machine Interface (HMI) devices for drivers to plan for a trip.

A key road block is the lack of information or wrong information which consumers currently have regarding the PHEVs and PEVs. The marketing teams of OEMs are developing various approaches to educate the public before launching a product. Recently, Tesla Motors provided demonstration sessions for the general public in various states and it has been observed that the short information session and display of the PEV features have changed the opinion of many observers.

Continued monetary incentives from federal and state government programs could further enhance the number of PHEVs and PEVs on the road.

It is hoped that the above mentioned prevailing barriers to the commercialization of the PHEVs and PEVs will slowly diminish with the advancement in the technology. However, as the automotive pundits are forecasting, numbers of PHEVs and PEVs will increase exponentially by the end of this decade, which leads to another challenge surfacing on the horizon, the provision of sufficient electric power supply. Current grids are already operating in heavily loaded conditions and are often faced with the steady increase in load demand. In spite of adoption of many precautionary measures, still all over the world, collapse of power systems or grid failures are common. These incur huge losses of tariff as well as industrial production. A simultaneous development of remote micro grids, sustainable energy based charging stations and Smart grid is essential for addressing the forthcoming increase in the charging demand of PHEVs and PEVs.

The Society of Automotive Engineers (SAE) is addressing these issues for continued advancement in the automotive arena through numerous measures. To regulate the PHEVs and PEVs charging, SAE's "Hybrid J2836, J2847, J2931 and J2953 Task Force" consisting of experts from academia and industry are collaborating to develop communication standards between vehicle and smart grid.

No one can predict the future, but it is hoped that ongoing numerous researches in this area will develop an optimum solution to the stated issues.

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