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THE CHANGING LANDSCAPE OF VEHICLE TECHNOLOGIES

Hybrid gasoline/electric vehicles, and some emerging all-electric vehicles, continue to grow as an alternative to the traditional gasoline engine, and will likely be a key growth opportunity going forward. However, that is not the entire story.

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INTRODUCTION

About two years ago, we published a report on the emerging hybrid/electric vehicle market, and the opportunities that could lie ahead. Interestingly, oil prices had just returned from their 2008 trip to \$147 per barrel, and fell all the way to the \$40 level. Oil prices, and the corresponding impact on gasoline prices, clearly have an impact on consumer buying behavior – notably, whether they purchase hybrid/electric vehicles or continue to buy those big, gas-guzzling SUVs. Fast forward two years, oil has once again made a run to the \$115 level (in April), causing another spike in gasoline prices to the \$4.00+ level, and again raising the debate over alternatives to the traditional gasoline-powered vehicle. The trials and tribulations of high oil prices and corresponding gas prices are likely to stay with us in the coming years.

Hybrid gasoline/electric vehicles, and some emerging all-electric vehicles, continue to grow as an alternative to the traditional gasoline engine, and will likely be a key growth opportunity going forward. However, that is not the entire story. Today, auto manufacturers are aggressively bringing a growing list of small (very small, in some cases), high miles-per-gallon (MPG) gasoline engine vehicles to market. Additionally, several auto manufacturers are offering a growing set of clean-diesel cars to the market that deliver 40+ MPG performance, and claim significantly reduced emissions. There is also a sizable push from a number of sources to support a transition to natural-gas-powered vehicles – most notably trucks like 18-wheelers, and a range of other commercial vehicles. Legislation is currently in Congress on this topic, in a third attempt to gain government support for such a program.

There are a number of new or improved vehicle technologies coming to market today or in the near future – all in an effort to offset the growing challenges of high oil prices, environmental concerns, and a growing global automobile market driven by emerging markets.

HYBRID AND ELECTRIC VEHICLES

Hybrids, or hybrid-electric vehicles (HEVs), continue to be one of the key growth opportunities among alternative vehicle technologies. The Toyota Prius continues to represent about 50% of the HEVs sold in the U.S., or approximately 140,000 of the roughly 275,000 hybrids sold in 2010 in the U.S., and about 62,000 of the 118,000 hybrids sold in the U.S. from January through May 2011 (according to www.hybridcars.com).

While the Prius is the leader in volume today, estimates point to over 100 hybrid and electric vehicle models set for release between now and 2015. As the market evolves and more manufacturers launch hybrids, what we see is that many of the most popular models are beginning to offer a hybrid version, attempting to leverage an already successful brand. For example, Lexus offers a wide range of hybrid versions of its models, and there are a growing set of models from the likes of Honda, Ford, Toyota, and General Motors – and even a model or two from BMW and Mercedes.

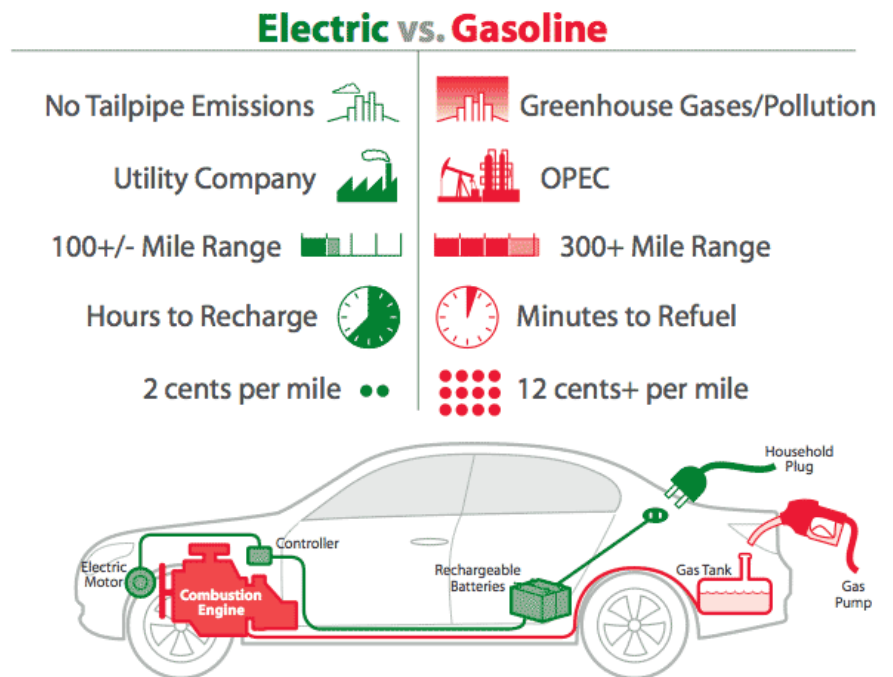
HYBRID/ELECTRIC TECHNOLOGY OVERVIEW

The typical hybrid electric vehicle (HEV) effectively offers two propulsion systems in one car. HEVs have a traditional internal combustion gasoline engine and traditional drive train, and an additional electric-motor-driven system, such that the car can operate solely on electric (battery) power and switch over to gasoline-engine power when the battery runs out. The obvious benefit is that you use less gasoline in a hybrid, therefore saving on fuel costs, plus you get to enjoy the good feeling of helping to save the planet.

Today, there are multiple variations of HEVs that use a range of battery power – some of which offer higher efficiencies than others. For example, “mild hybrids” provide some (potentially modest) benefit and increase your gas mileage, but they are not as beneficial as a more aggressive HEV. “Full hybrids” incorporate a larger set of batteries, use electric power a larger portion of the time, and result in more significant efficiencies and fuel savings.

In addition to today’s HEVs, an emerging class of hybrids is beginning to go into production – “plug-in hybrid electric vehicles”, or PHEVs. The primary example today is the Chevy Volt. PHEVs are different from the typical hybrid because there is no traditional drive train powered by a gasoline engine. The car is propelled solely by the electric drive system. However, there is a small gasoline engine that operates (when needed) only to charge the batteries for the electric drive. PHEVs have the potential to be significantly more fuel efficient than today’s hybrids.

Finally, at the very end of the spectrum is the all-electric vehicle, or EV, which has no gasoline engine whatsoever, and is completely powered by batteries and an electric motor. While still a tiny fraction of the car market today, new models are beginning to hit the market, with the Nissan Leaf at a price point of approximately \$33,000, and Tesla Motors' \$110,000 Roadster and upcoming \$50,000+ luxury sedan, called the Model S. Hybridcars.com illustrates the differences between the gasoline-powered car and an electric vehicle in the diagram below. However, while the costs per mile of the electric vehicle are likely much lower than gasoline cars, the cost per mile would certainly vary, based on the mileage of the gasoline-fueled car, the cost of electricity, and the cost of gasoline – all key variables in the economics debate over electric vehicles.



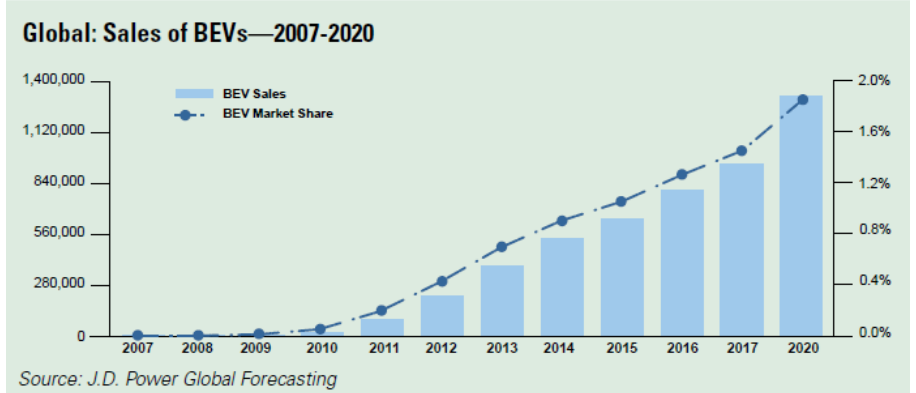
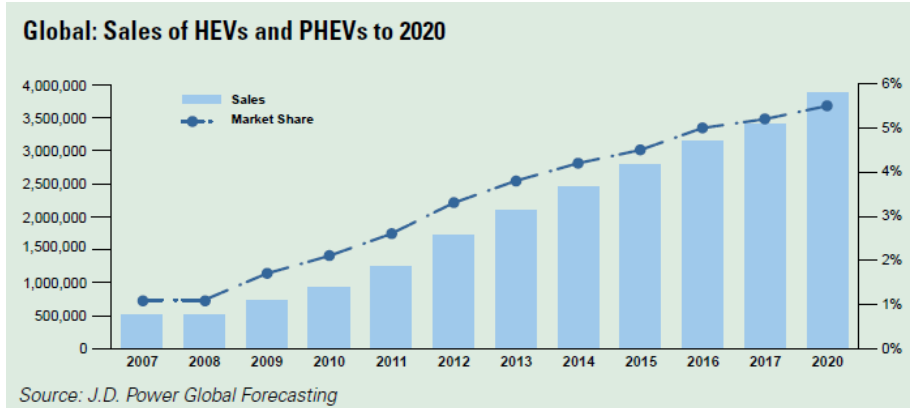
Source: www.hybridcars.com

MARKET OPPORTUNITY FOR HYBRIDS AND ELECTRIC VEHICLES

Hybrids are now selling in real volumes on a global basis. In the U.S., about 290,000 hybrids (HEVs and PHEVs) were sold in 2010, and on a global basis, about 935,000 hybrids were sold. This places the penetration rate – or hybrids as a percentage of the overall market – at 2.5% in the U.S. and 2.1% globally, based on about 44.7 million passenger vehicles sold globally in 2010. Interestingly, the Japanese market (home of the Toyota Prius) has an astonishing 11% penetration rate, with 476,000 hybrids sold out of a total of 4.3 million passenger vehicles – demonstrating that the rest of the world has a long way to go – but can get there.

According to industry analysts at J.D. Power Global Forecasting (see charts below), hybrids are expected to increase global market share from 2.6% in 2011 (1.2 million hybrids on 47.7 million total passenger vehicles) to 4.5% in 2015 (2.8 million hybrids) and 5.5% in 2020 (3.9 million hybrids).

In terms of electric vehicles (EVs – or Battery Electric Vehicles (BEVs), per J.D. Power below), the penetration rates are much lower – as this market is just beginning to get off the ground. Current EV penetration stands at an estimated 0.2% in 2011, and is expected to grow to 1.05% in 2015, and 1.85% in 2020.

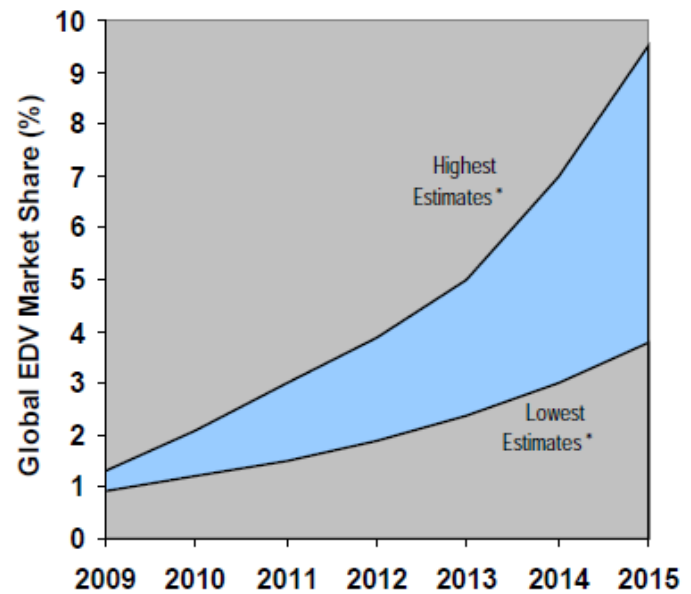


Note: “BEV” is Battery Electric Vehicle, a.k.a. “electric vehicle”, or EV

As it turns out, J.D. Power’s estimate is near the lower end of the range of industry analysts in terms of hybrid and electric penetration rates. While J.D. Power may be correct, there are also more aggressive estimates for growth out there, and the range of estimates are shown below. Note, “EDV” refers to Electric Drive Vehicles, which encompasses all hybrids and electric vehicles. Effectively, the range of estimates points to hybrid and electric vehicles reaching between 3.5% and 9.5% of the global market by 2015 (J.D. Power estimates about 5.5%).

While the estimates vary, the consensus viewpoint is that hybrids and electric vehicles are likely to continue to gain share in the global market, providing investment opportunities across many parts of the

value chain – whether it be vehicle makers themselves, battery manufacturers, or other key components set to exhibit significant growth.



Source: Polypore International, Inc.

CLEAN DIESEL VEHICLES

Another movement in the fight against gas guzzlers is the efficient, clean-diesel burning engine. Many people remember the old, smelly diesel cars from 20+ years ago. However, today there is a new generation of very efficient, high-mileage “clean diesel” engines that are already in the market – and more are on the way. Volkswagen is one of the leaders in this area, and is delivering vehicles with fuel efficiencies above 40 mpg. These “clean diesel” vehicles run on regular diesel fuel, or other biodiesel fuels.

Eliminating the need for petroleum-based fuel is the path of the electric vehicle, but another strategy is to get as many miles out of a gallon of fuel as possible. Additionally, with these clean diesel vehicles, tailpipe emissions are dramatically lower than the traditional gasoline-powered car – providing another key benefit in our efforts to save the planet.

As mentioned above, Volkswagen is a leader in the clean diesel arena, and its VW Jetta is the clear volume leader in the U.S., selling about 22,000 units from January through May 2011, out of 39,400 total clean diesels sold – about 56% share. When you include Volkswagen’s other diesel models – the VW Golf, Audi A3, Audi Q7, and VW Touareg – its market share climbs to about 30,600, or about 78% of the units sold in the U.S. in 2011. Other makers are also in the market in small volumes – including BMW, Mercedes, and Chrysler’s Jeep Grand Cherokee.

At about 39,400 units, clean diesel vehicles have sold about 32% of the number of hybrids and electrics in the U.S in 2011 (~122,500 through May). With additional announcements from Volkswagen's Audi unit about additional models coming to the U.S., and other manufacturers' efforts, clean diesel is likely to be an interesting option for consumers in the coming years.

EFFICIENT GASOLINE-POWERED VEHICLES

Another result of high gasoline prices is automakers' shift toward selling smaller vehicles and vehicles with smaller engines. While these vehicle sizes have long dominated European roads – largely due to their long history of much higher consumer gasoline prices – they are now becoming a growing part of the U.S. market. Models like the Smart Car, Honda Fit, and a new U.S. presence from Fiat (to name just a few), are showing that there is a market in the U.S. for these ultra-compact cars.

The driver behind this market shift is higher current and expected future gas prices. Many consumers are looking to maximize their fuel economy due to gas prices as well as the more challenging macroeconomic environment of the last few years. Whether this trend continues to build in the U.S. remains to be seen; however, we know from hybrid sales that when gas prices drop significantly, Americans tend to go back to buying their big, inefficient cars and SUVs.

NATURAL GAS-POWERED VEHICLES

Natural gas is a petroleum-based energy source that is very abundant in the United States, largely due to major discoveries in recent years and the proliferation of new production techniques. Because of these significant discoveries and supply/demand dynamics (and likely a host of other reasons), natural gas prices have been depressed for the last couple of years. We all know about the U.S. dependence on foreign oil, and the country's desire to reduce this dependence. Natural gas vehicles (NGVs) are one way to get there.

T. Boone Pickens, a long-time successful Texas oil businessman and investor, has made it his mission for a number of years to convince the American public and politicians that converting vehicles (trucks, buses, and other commercial fleets, at least initially) to natural gas is an excellent way to reduce our dependence on foreign oil, leverage an inexpensive (at today's prices) American natural resource, and to implement a cleaner-burning fuel to reduce emissions. Legislation is in the U.S. Congress today (for the third time) in an effort to gain government support and incentives to drive conversions to natural gas.

According to the group NGV America, there are over 10 million NGVs in operation today, globally – although only about 130,000 of them are in the U.S. “The Pickens Plan” calls for the migration of a significant portion of America’s 18-wheelers, buses, garbage trucks, taxis, and other commercial fleets to natural gas fuel, reducing our oil consumption and keeping in the U.S. economy a portion of the \$350-450 billion per year America spends on foreign oil. The technology is here today, and the potential migration of a portion of the vast fleets of trucks, buses and other commercial vehicles in the U.S. could drive significant growth opportunities.

ALTERNATIVE FUELS

In addition to the multiple vehicle technologies discussed above, there is a range of fuels and fuel technologies that could become meaningful alternatives to the traditional gasoline and diesel fuels in use today. The most direct replacements for these two fuels are ethanol (for gasoline) and biodiesel – both considered biofuels, and considered sustainable energy resources. Ethanol is made from carbon-based feedstocks such as sugar cane or corn, among others, while biodiesel is created from feedstocks such as used cooking oil and animal byproducts. A third emerging biofuel option is “renewable oil” which then is processed in traditional refineries. One promising technology today produces oil from micro-algae.

While these fuels have shown promise in recent years, there are also significant debates over the environmental impacts of growing the agricultural feedstocks, the impact on the food supply, and the amount of energy it takes to process and refine the biofuels. With all that said, there still may be growth opportunities for these biofuels going forward. For example, U.S. biodiesel production is expected to more than double from 2011 to 2015, from 800 million gallons to about 1.9 billion gallons.

Looking to the hybrid and electric vehicle markets, the “fuel” required in these vehicles is electricity – effectively stored in a battery. Battery technology is a key factor in the success of the transition to hybrids and electric vehicles. While the initial Toyota Prius used Nickel Metal Hydride (NiMH) batteries, the newest models predominantly use lithium-ion batteries. Lithium-ion batteries are a key, strategic technology, and a great deal of investment has been (and continues to be) made to ramp manufacturing capacity and reduce costs. The battery industry will likely remain a strong growth and investment opportunity in the coming years.

CONCLUSION

While the ultimate winners and losers are not necessarily decided across vehicle and fuel technologies, there will likely be many investment opportunities across this dramatically changing industry for advanced vehicles. We look for potential investment opportunities in a number of areas:

- Vehicle manufacturers – Most (but not all) of the hybrid and electric vehicle manufacturers are also traditional auto manufacturers. Those developing the winning hybrids and EVs could outperform their competitors.
- Engine technologies – Whether migrating to clean diesel, natural gas, or efficient gasoline vehicles, advanced engine technologies could be a/the differentiator that determines the winners.
- Powertrain technologies – Electric vehicles require a largely different powertrain from traditional internal combustion-engine-based vehicles.
- Battery and related component suppliers – Batteries are a key technology required for the success of the hybrid/electric market, and the leading suppliers could represent investment opportunities.
- Biofuels and other alternative fuels – As the industry works to offset petroleum-based fuels with blends or replacement with biofuels, these manufacturers could pose interesting growth opportunities.
- Infrastructure providers for electric and natural gas vehicles – If the transportation industry makes progress in migrating to electric and natural-gas vehicles, the corresponding infrastructure will need to be put in place to support these vehicles. This includes charging stations and power hookups for EVs and natural gas fueling stations for NGVs. These could provide substantial growth opportunities.

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