ClearBridge Investments

Disruption from Electric Vehicles Presents New Growth Opportunities

Electric Vehicles (EVs) are a potentially disruptive technology that we believe will transform the automotive industry. With more than one million such vehicles on the road globally today, a number that could reach 20 million by 2020, EVs could follow the likes of the smartphone, social media and the internet in sparking rapid consumer adoption. Like disruptive technologies before it, the electric vehicle has the potential to transform its industry and a multitude of associated industries. From the natural gas and power generation sectors to the entire vehicle supply chain, the EV ecosystem is changing rapidly and we believe new growth opportunities are being generated around the world.

The EV is already global in nature as costs and barriers to entry have begun to decline, and we are beginning to see growth in potential investments along the EV chain. These include vehicle manufacturers and battery producers in the U.S. and Asia, lithium and other raw materials miners in Latin America, as well as semiconductor and other electronic component makers in Europe. To understand why we believe EVs are on a disruptive path and what that means for global investors, it helps to first understand the technology behind EVs and why this will support rapid adoption over the next two decades.

EVs Have Several Advantages Over Conventional Vehicles

Cost of ownership is potentially the greatest advantage electric vehicles enjoy over those powered by internal combustion engines (ICEs). According to research conducted by the Idaho National Laboratory, electric cars can be charged on a per-mile basis anywhere from three-to-10 times cheaper (depending on location) than it is to fuel a conventional car, largely because electric motors are much more energy efficient than ICEs. This feature makes EVs potentially very attractive not only to consumers but also fleet operators, which have cars driving long distances throughout the year. Any business model in which the cost of fuel is more important than the cost of the equipment will benefit from having a fleet of cars that are cheaper to charge.

Enhanced power and handling are another attraction of EVs. One of the key features of an electric motor is its ability to deliver almost instant torque, making EVs very punchy to drive compared to high octane gas engines. In addition, better handling comes due to the lower center of gravity in EVs, as electric batteries are located at the bottom of the car. This feature may also reduce the risk of rollovers and makes EVs safer to drive.

Batteries Are The Key To Rapid Adoption of EVs

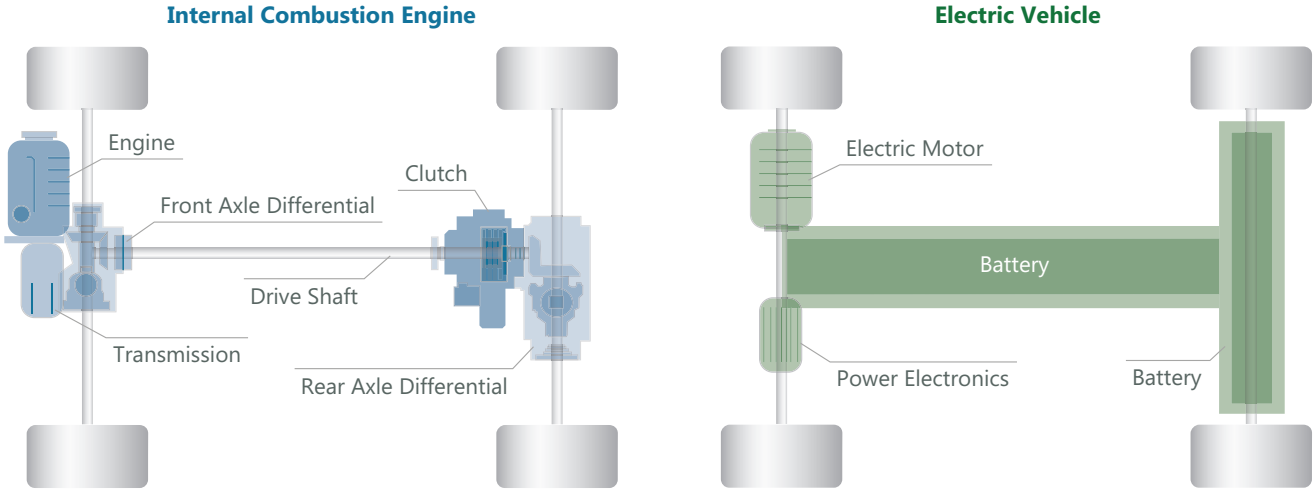
Over the last few years we have seen a dramatic improvement in the cost per kilowatt hour (kWh) of lithium-ion (li-ion) batteries, which have fallen 70% over the last six-to-seven years. We are also seeing substantial investment in li-ion battery capacity from more obvious names like Tesla and other players like China's BYD and Korea's LG Chem, which are targeting energy storage and electric car applications. These investments will dramatically increase the scale of the li-ion battery industry, which should lead to improvement and optimization in various production processes, and thus lead to even lower costs per kWh in the future, as seen in Exhibit 2. According to various estimates, battery costs can decline by a further 50-70% per kWh by the middle of the next decade.

Lower battery costs should allow the auto industry to offer much cheaper and competitive electric cars. By the middle of the next decade, we expect the auto industry to produce cars that offer a relatively long range of more than 200 miles per charge and are also price competitive with average or even low-end gasoline cars. Extended range is one of the most important requirements for EVs to grow rapidly, as a recent study by Important Media shows that 75% of respondents who do not currently drive an EV would consider purchasing one if it can deliver at least 220 miles per charge. Most EVs on the market today offer less than 100 miles per charge. High end models like Tesla do offer a more than 200-mile range, but come at a premium price point.

EV adoption is also supported by national policies, targets and tax breaks in the United States and around the world. This is another reason why we see EVs as a global growth industry – governments in both developed and emerging markets have implemented tax breaks, rebates and stringent tailpipe-emissions standards designed to get manufacturers and consumers to switch to EVs.

It is tough to predict what the course of EV adoption will look like, but according to our simulations, as seen in Exhibit 3, EV adoption may hit an inflection point sometime in the middle of the next decade. By 2030, global new EV sales could hit 60 million and comprise nearly half of all new car sales. And if history is any guide, once disruptive technologies reach that inflection point, adoption expands rapidly.

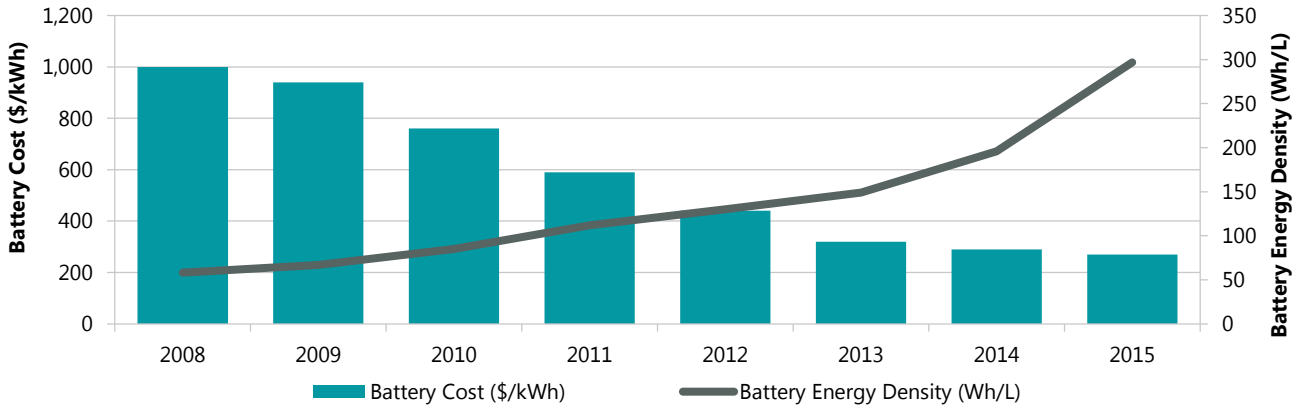
Exhibit 1: Comparing ICE and EV Powertrains



Key Advantages EVs Have Over ICE Cars:

- Cheaper to maintain because EVs contain far fewer mechanical parts (no clutches, valves, etc.)
- No need to change engine oil, air filters or transmission fluid
- Faster acceleration
- Better handling due to lower center of gravity

Exhibit 2: Evolution of Battery Energy Density and Cost



Source: International Energy Agency: Global EV Outlook 2016. Notes: $/kWh = U.S. dollars per kilowatt hour. Wh/L = watt hours per liter. Values based on estimates of Department of Energy data.

Rapid Adoption Means New Growth Opportunities

As EVs comprise a growing share of new car sales, new growth opportunities will emerge for a wide-range of high-tech manufacturers, power producers and energy suppliers.

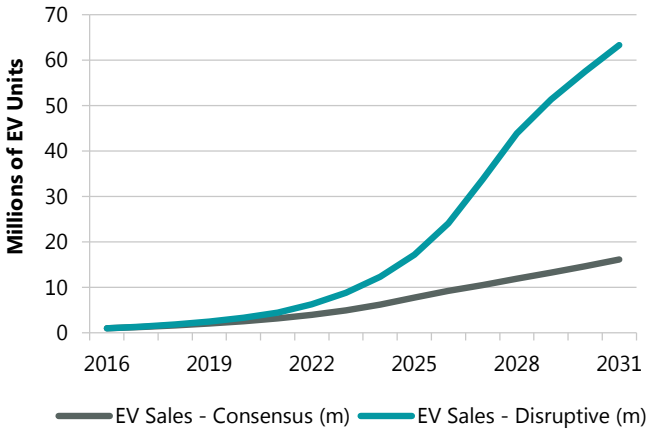
EV Supply Chain: The primary components of an EV powertrain include the electric motor, battery and power semiconductor. Production of these parts, batteries in particular, will need to ramp up dramatically to meet demand. This deficit is one of the reasons why Tesla Motors is constructing its Gigafactory, which the company says is expected to supply batteries for 500,000 Tesla EVs in 2020, in addition to lowering battery costs over time. Other early movers in the li-ion battery space should also benefit, particularly as more automakers begin the shift to EVs. Volkswagen, for example, recently announced its goal to produce more than 30 electric-only vehicle models by 2025, with EVs comprising 20-25% of the automaker's total sales. Companies like Samsung, LG Chem and Panasonic, which partnered with Tesla on its Gigafactory, as well as newer entrants in China and Taiwan that hope to leapfrog existing ICE technology into the EV space, are already growing their li-ion battery business and could take advantage of this growing opportunity.

In addition, lithium and other key raw materials will need to be mined at a higher rate to meet the battery-producers' needs. This presents opportunities for miners with operations in the largest lithium-producing countries – Australia and Chile.

Finally, on-board power semiconductors from major European companies like Infineon Technologies, Bosch and NXP are vital components of electric vehicles, particularly since they help regulate battery efficiency and performance. Companies with an initial toehold in this space would also stand to benefit from rapid global adoption of EVs.

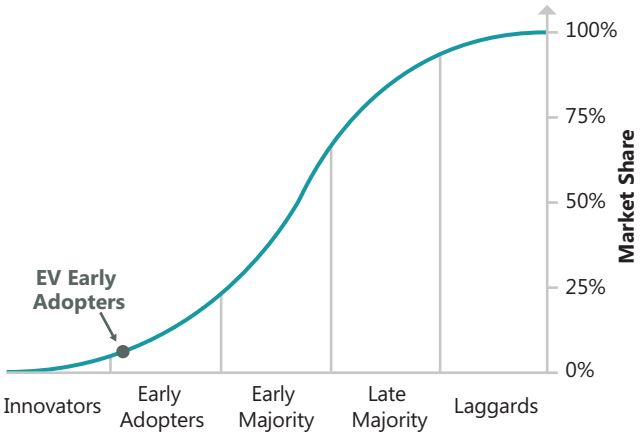
Power Generation: Electrification of the auto fleet could be a long-term game changer for the power industry, where demand has been stagnant for the past 10 years. EVs should start meaningfully adding to electric consumption post-2020, roughly 0.5-1.0% per year in the United States. In addition, because EV charging typically occurs during off-peak hours, power prices and profitability margins for around-the-clock and off-peak generating facilities should see an uptick. We see potential benefits for numerous utility companies such as Exelon, Sempra Energy and Edison International, as well as wind power operators and

Exhibit 3: Global New EV Sales (estimates)



Source: Deutsche Bank, Bernstein, Credit Suisse and ClearBridge analysis.
Note: EVs include both battery electric vehicles and plug-in hybrids.

Exhibit 4: Technology Adoption Curve for Modern Innovations



Source: The State Government of Victoria (Australia). Note: This graph displays how new technologies rapidly become ubiquitous after gaining market share from early adopters. Now-universal technologies, such as electricity, refrigeration, television and the mobile phone, all followed a similar path to the S-curve. Electric vehicles today are entering the "early adopters" phase, as new EV sales continue to accelerate and the technology gains market share.

developers like NextEra Energy and Denmark's Vestas Wind Systems. Exhibit 5 shows the potential impact of EV adoption on annual power demand growth, which could reach nearly 5% by 2030. Beyond direct benefits from greater consumption, the electric fleet's expansion should create opportunities for incumbent utilities and retail providers to build out public charging stations, improve demand-side management and upgrade the electric grid.

Natural Gas: Increasing demand for electricity as EVs become more widespread will have positive effects for energy producers, particularly the natural gas industry. As a result of falling prices, natural gas has already grown as a percentage of overall U.S. power production, from 20.1% in 2006 to 32.7% in 2015, according to the U.S. Energy Information Administration. Growing electricity needs resulting from EV adoption both in the U.S. and globally call for a relatively cheap, clean and abundant fuel. Natural gas, a recent share taker, is the likely fuel to benefit from rising power usage. This trend should boost low cost natural gas producers and liquefied natural gas suppliers.

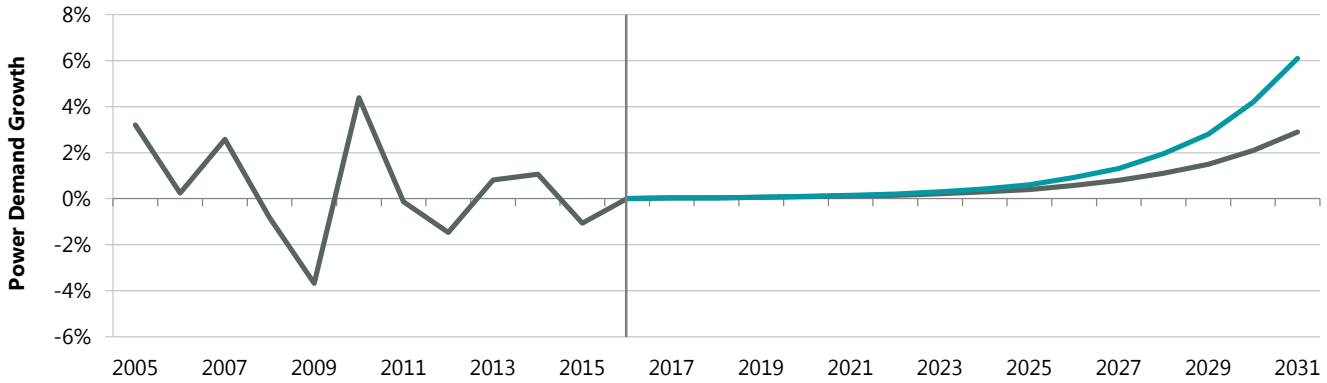
Conclusion

EVs have the potential to be a disruptive technology that will not only transform the automotive industry, but also related sectors and component suppliers. EV expansion should provide new growth engines for high-tech manufacturers in the EV value chain, as well as boost demand in the power sector and potentially support continued growth in natural gas production. The cost and range of batteries, as well as the availability of charging stations, are the key to whether EVs become the standard vehicle technology of the future. Our view is that these issues will largely be resolved within the next decade. When this occurs, your neighbor's new EV will no longer be a curiosity. Rather, it will be the vehicle of choice for consumers around the world, creating a sea change in the automotive industry and generating the type of sustainable growth opportunities that we look for across our global investment universe.

EV Impact on Crude Oil

Crude oil will likely lose energy market share as EV adoption accelerates with meaningful impact in the middle of the next decade or beyond. While we do not anticipate oil demand will shift as a result of EVs over the next several years, by the middle of the next decade oil demand growth may start to decelerate in the "disruptive" case for EV adoption.

Exhibit 5: EV Penetration Impact on U.S. Power Demand



Source: Department of Energy, ClearBridge analysis. Note: This graph shows the difference in potential U.S. power demand between consensus EV adoption estimates and ClearBridge's analysis of disruptive-case EV adoption estimates.

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