Industry Analysis

The Road Ahead for Electric Vehicles

Marcial Nava

- **Electric vehicles have become more reliable and attractive due to technological progress and government support**
- **However, prospects for mass adoption are still constrained by technological limitations, charging infrastructure, policy uncertainty and oil prices**
- **Financing the purchase of electric vehicles represents an opportunity for banks that can effectively tailor their products**
- **The electrification of transportation is a global trend that will intensify in the following years**

Introduction

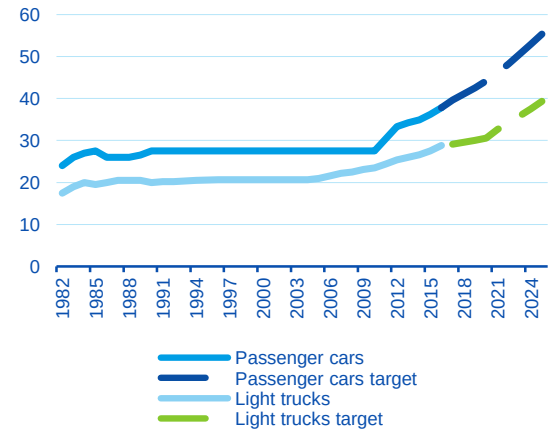
The 2016 Paris Auto Show was marked by the introduction of several models of electric vehicles, many of which will become available to consumers as early as 2020. Electrification, or the use of battery powered electric vehicles, is a major trend in today's auto industry along with automation and ride-sharing. Electrification has gained relevance in the context of the Paris Agreement, which set the goal of keeping the increase in global average temperature below 2°C above pre-industrial levels, preferably 1.5°C. Transportation is a natural target for decarbonisation initiatives since it accounts for a third of total greenhouse gas emissions to the atmosphere. As efforts to mitigate the impact of global warming intensify, governments, scientists and auto manufacturers are working against the clock to accelerate the electrification of transportation that is currently powered by fossil fuels. The challenge is to make electric vehicles reliable, appealing and accessible to the vast majority of drivers. In this brief, we examine the state of the electric light-duty motor vehicle market in the U.S. and describe some of the challenges and opportunities for the following years. From here on, the term "plug-in electric vehicle" (PEV) refers to the segment of light-duty motor vehicles that can be plugged-in and are powered partially or entirely by electricity stored in a battery. The definition includes: plug-in electric hybrids (PHEV) and pure electric (EV) vehicles. As of 2015, the U.S. held about 30% of the stock of PEVs in the world.

A Brand New Market

The development of the modern electric car can be traced back to the 1970s, when concerns about air quality and dependency on foreign oil led to the establishment of fuel economy and tailpipe emission standards. Created by Congress in 1975, the Corporate Average Fuel Economy standards (CAFE) require each auto manufacturer to produce cars and trucks that, together, yield an average amount of miles per gallon. CAFE standards have tightened through the years, leading auto manufacturers not only to improve the efficiency of fossil fuel powered vehicles, but also to develop alternative fuel vehicles that could compensate for the more profitable but less efficient SUVs and trucks that are widely preferred by U.S. drivers.

Figure 1

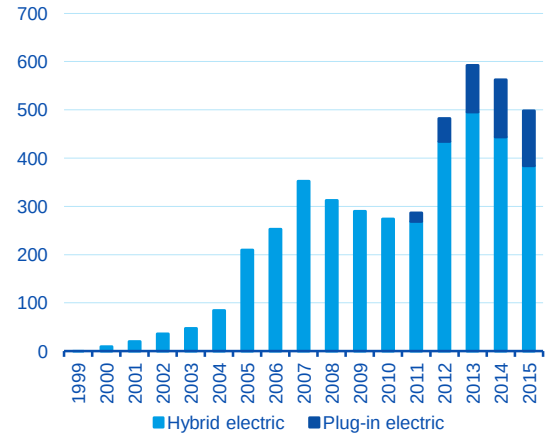
U.S. Fuel Economy Standards (miles per gallon)



Source: BBVA Research and Haver Analytics

Figure 2

U.S. Electric Vehicle Sales (thousand units)



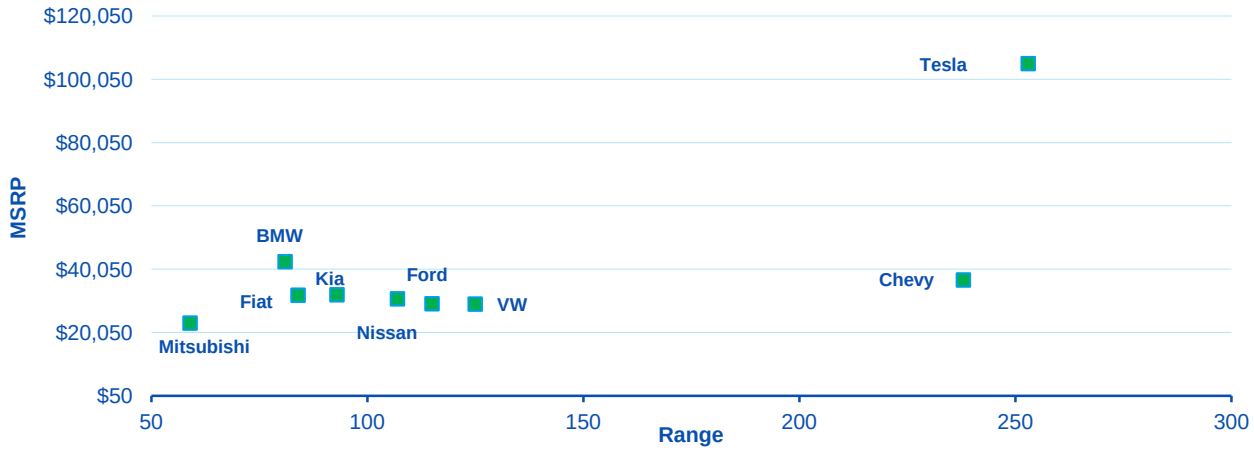
Source: BBVA Research and U.S. Department of Energy

The first commercially available electric cars appeared in the form of hybrid electrics (HEV), which are powered by an internal combustion engine (ICE) and an electric motor that takes energy from a battery. The battery recharges by regenerative braking rather than by being plugged-in. The Honda Insight (1999) and the Toyota Prius (2000) were the first HEV models introduced to the U.S. market. Since then, around 60 models of HEVs have been launched and approximately 4.2 million units have been sold as of 2016. Plug-in electric vehicles came a decade later with the introduction of the Chevy Volt in 2011 and the Nissan Leaf in 2010, followed by the Tesla Model S and the Toyota Prius PHEV in 2012. Today, there are about 28 different models of PEVs with nearly 517,000 units sold as of 2016. Although the number of plug-in electric models has increased over time, the market is highly concentrated with Nissan, Chevrolet, Tesla and Toyota accounting for roughly 70% of sales.

Despite their relatively short presence in the market, both HEV and PEV sales have grown significantly. Hybrid electrics experienced a significant boost in 2005 due to tax incentives and rebates to consumers, and again in 2012 due to the economic recovery and the tightening of CAFE standards as well as elevated gasoline prices. Meanwhile, PEVs gained momentum after 2013 due to battery improvements, expanded charging infrastructure, fiscal incentives and economic growth. Even with these favourable trends, both types still account for a small fraction of the market for light-duty vehicles: 2% in the case of HEVs and 1% in the case of PEVs. However, high growth rates and small market shares are common among innovative products that are new to consumers. Thus, in order to capture a greater market share, PEV sales must sustain high growth rates for a prolonged period of time. This trend is not guaranteed, though, as there are challenges that need to be overcome.

Figure 3

Plug-in Electric Vehicles (selected brands and models*)



*2017 models include: Tesla Model S - P85D, Kia Soul Electric, Fiat 500e, Nissan Leaf, BMW i3, Ford Focus Electric, Chevrolet Bolt EV, VW e-Golf, Mitsubishi i-MiEV. Source: BBVA Research, U.S. Department of Energy and Company Websites

Challenges for Mass Adoption

Despite benefits like fuel savings, home or work recharging, energy efficiency, noiseless driving, instant torque and low to zero emissions, electric vehicles have not entirely imbued the **preferences** of American drivers. A survey conducted by the National Renewable Energy Laboratory (NREL) in 2015 revealed that 52% of respondents were not able to name a specific plug-in electric vehicle make and model, and only 20% of respondents said they would "consider or expect to" get a pure electric vehicle in their next purchase or lease. Consistent with market share figures, only 4% of households claimed to have a HEV and 1% reported owning a PHEV and EV, respectively. The main factors that deter consumers from purchasing an electric car are cost, range and charging infrastructure. [1]

"Range anxiety" or the fear of being stranded on the road because of a loss of power, is a frequent deterrent of EV sales. It is commonly agreed that a range of 200 miles per charge is sufficient to overcome this fear, despite the fact that, according to the Federal Highway Administration, 80 miles of battery range would be sufficient for 90% of all household vehicle trips in the United States. Currently, the majority of EV models have ranges between 60 and 120 miles per charge, while only a few (and generally more expensive) models go beyond the 200 miles threshold.

1: Singer, Mark. 2016. "Consumer Views on Plug-in Electric Vehicles –National Benchmark Report." National Renewable Energy Laboratory. https://goo.gl/F1WyRd

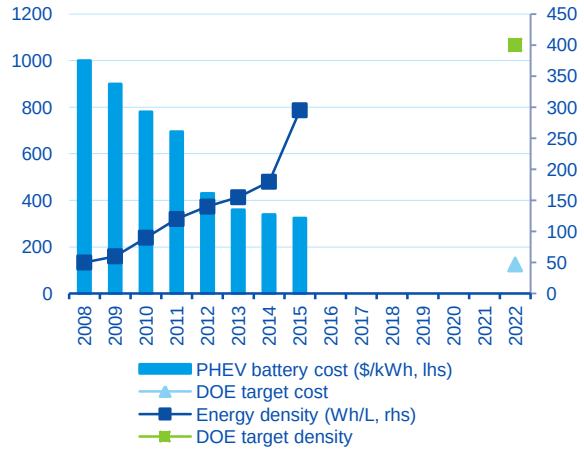
Charging infrastructure is often cited as a key driver of sales despite the fact that most drivers charge their vehicles at home. There are 14,660 public electric stations as opposed to the approximately 120,000 gas stations in the country. Although the ratio of public charging stations to electric vehicles is much higher than the ratio of gas stations to internal combustion, the frequency at which electric vehicles need to be charged makes the accessibility of charging infrastructure critical for the adoption of electric vehicles on a large scale. Not surprisingly, cities with more charging stations have higher sales of electric cars. Unlike gas stations, which are placed based on traffic, public AC Level 1 and 2 charging stations tend to be placed where there is a high concentration of vehicles parked for long periods of time such as shopping malls, city parking lots and garages, airports, hotels and private and public office buildings. In particular, charging stations in the workplace tend to increase the commuting range of electric cars.

Cost is another important element deterring large sales. The price of a pure electric sedan is about 17% higher than the price of a standard vehicle. Efforts to improve cost competitiveness of electric vehicles have focused primarily on the battery, which accounts for about a third of the total cost. Lowering the cost of the battery pack would allow manufacturers either to reduce vehicle prices or to offer more battery range for the same price. The average cost of a lithium-ion battery pack — the standard technology behind the electric vehicle battery — has dropped from $1,000/kWh in 2010 to $350/kWh in 2015. However, this is not enough. According to Bloomberg New Energy Finance (BNEF), battery prices need to fall below $200/kWh in order to make battery-operated electric vehicles competitive with the internal combustion engine. BNEF analysis suggests that cost parity could be achieved in the first half of the next decade. [2] In addition to battery improvements, higher oil prices could contribute to make electric vehicles more attractive and accelerate mass adoption; however, this may not be the case in the following years. Covert, Greenstone and Knittel (2016) calculated that oil prices have to go beyond $350 per barrel so that an electric car with a battery price of $325/kWh becomes cheaper to operate than a gasoline-powered vehicle. During the Obama administration, the Department of Energy set the goal of lowering the battery price to $125/kWh. However, according to the above mentioned study, this target would still imply a breakeven price of oil of $115 per barrel.[3] Our analysis suggests that such price has a low probability of occurrence. [4]

2:Bloomberg New Energy Finance. 2016. “Electric Vehicle Cost Competitiveness. Only Batteries Have the Answer.”
3: Covert, Thomas, Greenstone, Michael and Knittel, Christopher, R. 2016. “Will We Ever Stop Using Fossil Fuels?” Journal of Economic Perspectives. Vol. 30. No.1. Winter. Pages 117-138.
4: BBVA Research. 2017. “Oil Price Outlook.” February. http://bbva.info/2l9iyA2

Figure 4

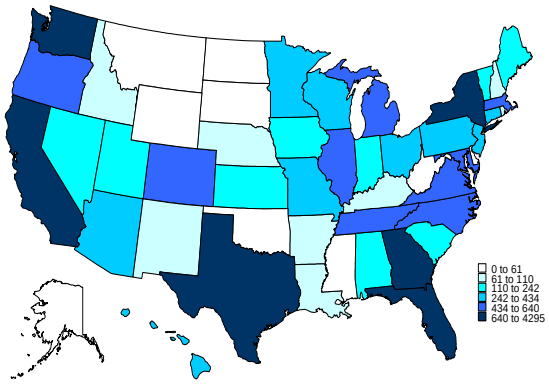
PHEV Battery Cost and Energy Density



Source: BBVA Research and U.S. Department of Energy

Figure 5

Electric Charging Stations by State



Source: BBVA Research and U.S. Department of Energy

The Case for Government Support

The public sector has played a critical role in the development of the electric vehicle market. At the time of writing, there are 28 programs at the federal level that touch different aspects of electric vehicles, including public transportation, charging infrastructure, research and development, equipment manufacturing and federal fleets. Government intervention has been justified on the basis of environmental concerns, job creation and energy security. In 2012, the U.S. Department of Energy, in consultation with several stakeholders in the public and private sectors, set the goal of making PEVs cost competitive with gasoline-powered vehicles by 2022. This *EV Everywhere* challenge would be achieved by focusing on three major technical issues: 1) lowering the battery cost to $125/kWh, 2) cutting the vehicle's weight by 30% and 3) bringing down the cost of electric drive systems from $30/kW to $8/kW.[5]

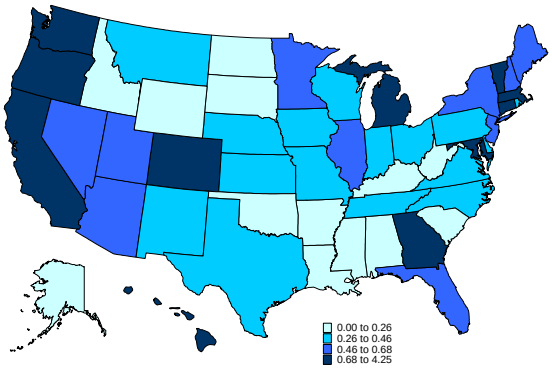
The federal government has also supported the manufacturing of electric vehicles by providing grants and loans to automakers. The Advanced Technology Vehicle Manufacturing program, which was established to support improvements in fuel economy, has a $25bn loan package from which $8.4bn has already been loaned to some manufacturers. Government-sponsored R&D has also played an important role in improving the quality and cost of batteries. Innovations like the nickel metal hydride battery used in first generation HEVs and the lithium-ion batteries used in the Chevrolet Volt were possible due to research supported by the Vehicle Technologies Office of the U.S. Energy Department.

5: U.S. Department of Energy. 2014. "EV Everywhere Grand Challenge. Road to Success." https://goo.gl/q6t3u5

The federal income tax credit, established in 2011 for the purchase of qualified plug-in electrics, is perhaps the most important of all government measures affecting the EV market. The maximum amount of credit allowed is $7,500 for the first 200,000 units sold by the manufacturer. It is estimated that this tax credit has been responsible for about 30% of total plug-in electric sales in the country. State and local governments also have their own set of mandates and programs supporting electric vehicles. According to the U.S. Department of Energy, California has more than 50 programs, including a rebate of up to $2,500 for the purchase or lease of plug-in electrics. Texas, on the contrary, only has eight while Kansas and South Dakota have none. Mandates are also an important feature of state incentives. For example, the California Air Resources Board has required that zero-emission vehicles account for a fraction of each automaker's sales, starting at 4.5% in 2018 and rising to 22% by 2025. Connecticut, Maine, Maryland, Massachusetts, New Jersey, New York, Oregon, Rhode Island and Vermont have similar mandates. These programs are crucial to increase EV usage as there is a positive correlation between state incentives and EV registrations.

Figure 6

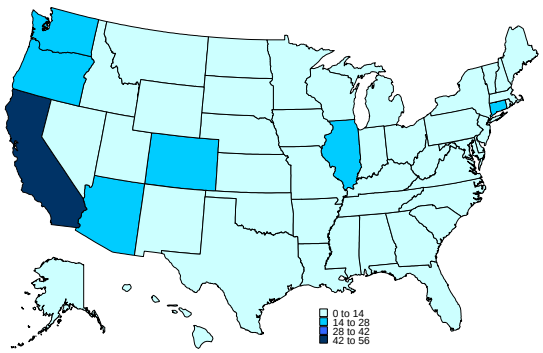
PEV registrations per 1,000 people



Source: BBVA Research and Haver Analytics

Figure 7

Number of regulations supporting PEVs



Source: BBVA Research and U.S. Department of Energy

Public Policy and Prospects for Mass Adoption

Given the current state of technology and relatively low oil price, mass adoption of electric vehicles will be very difficult to achieve unless major technological breakthroughs trigger a significant substitution effect.

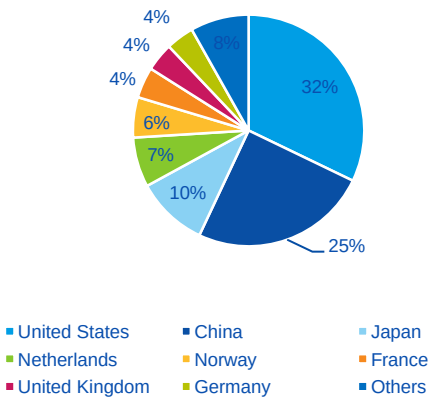
As a result, electric vehicles will still need temporary government support. However, at the time of writing, it is unclear if the new administration and the Republican majority in Congress will keep or expand the programs and incentives aimed at making electric vehicles more appealing and accessible. In particular, the future of the $7,500 tax break is highly uncertain given Republicans' preferences for tax code simplification and the need to contain the fiscal deficit in light of potential reductions to corporate taxes. Eliminating this tax incentive would

make existing and new models more expensive relative to gasoline-powered options. Nevertheless, some models have gained sufficient demand to resist the impact of unfavourable policies. Another source of uncertainty is the future of vehicle emission standards. The Obama administration established ambitious goals for lowering emission standards, which were to be achieved by 2025. However, these goals have been opposed by the auto industry under the premise of high compliance costs. As the new administration engages in the deregulation of several industries, there is a high probability that the emission standard goals will be modified or removed. If this turns out to be the case, incumbents would lose a strong motivation to invest in alternative fuel technologies.

Although tax incentives may be modified or removed to reduce the fiscal burden, supporting the development of electric vehicles makes sense not only from an environmental perspective but also from the standpoint of energy security and job creation. These also happen to be two top priorities of the new administration. In this context, the expansion of battery-powered vehicles could help reduce the country's reliance on imports of foreign oil while contributing to the creation of well-paid jobs. In fact, some of the most popular models like the Nissan Leaf and the Tesla Model S are assembled in the United States. In addition, backing the research and development of advanced batteries facilitates the creation of start-ups that generate jobs, foster innovation and bring the advantages of technological breakthroughs to consumers. For example, projects like the Tesla Gigafactory (which will produce batteries for the company) promise to create thousands of jobs in high-tech manufacturing. Supporting the electric vehicle would also help maintain U.S. technological leadership in the electrification of transportation — a trend that has become global.

Figure 8

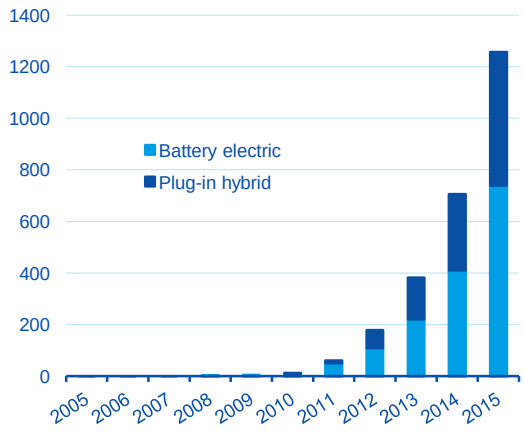
Electric Car Stock (EV and PHEV) in 2015



Source: BBVA Research and International Energy Agency

Figure 9

Global Stock of PEVs (thousands)



Source: BBVA Research and International Energy Agency

Financing Electric Vehicles

Leasing is the primary source of financing for buyers of electric vehicles, with a penetration rate of about 75%. Leasing makes sense in the early stages of adoption as it reduces concerns over the resale value and the performance of the battery over time. As technology changes rapidly, lessees of EVs have the opportunity to replace their vehicles with the latest technological breakthroughs in a relatively short period of time. Some financers have used the $7,500 tax credit as a form of down payment. Financing options are not limited to the vehicle since the battery and charging equipment can also be leased. Leasing the battery allows the consumer to avoid the risk of having to make large expenditures for repairing or replacing the battery.

In addition, some financers bundle the cost of home charging units and installation with the vehicle's financing. The average cost of a standard 240V charging station ranges between $1,100 and $1,200, including installation. At current prices, electric vehicles are more appealing to the mass affluent and affluent segments of the consumer spectrum. These segments seem to have increased their appetite for electric vehicles as suggested by the 400,000 pre-orders of Tesla's new Model 3 to be delivered by mid-2018. The company is planning to expand its production capacity to 500,000 vehicles by 2018, 10 times higher than the number of vehicles produced in 2015. Lenders that finance the purchase of electric vehicles are likely to be at a competitive advantage when tapping other markets. For instance, EV owners may also become users of solar roofs or home batteries that could also be financed.

Bottom Line

The U.S. remains a critical market for electric vehicles and manufacturers are expected to continue developing new and better models. The electrification of transportation is gaining momentum not only in the U.S. but also in other important markets like Europe and China. Thus, even if the U.S. abandons the Paris Agreement, moderates or even eliminates federal incentives and subsidies, some states, together with other countries around the world, are still expected to accelerate their transition towards a clean economy, implementing policies to make plug-in electrics more pervasive.

Innovation in advanced batteries is expected to continue, making electric vehicles more competitive over time. However, because of continuous improvements in the internal combustion engine and the relatively low price of crude oil, a complete switch from gasoline to electricity is unlikely in the short-term unless technological breakthroughs bring the price of battery packs well below $125/kWh or countries around the world significantly raise the cost of carbon emissions. Therefore, the baseline scenario for upcoming years points to a mixed stock of vehicles with an increasing penetration of electric options rather than a complete displacement of the internal combustion engine.