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Tesla Motors (in 2013): Will Sparks Fly in the Automobile Industry?

AUGUST 8, 2013. It is 1:04 a.m. in Fremont, California, and Tesla Motors CEO, chairman, and product architect, Elon Musk, is wide-awake at his desk in the Tesla Motors manufacturing facility taking the last sip from a can of low-carb Monster Energy drink. He has barely slept in two days and has over 250 unread e-mails in his inbox, 40 some new messages on his voicemail, and a full day of meetings ahead of him that are unlikely to end before 10:30 p.m. In addition, he has a board of directors meeting that is fast approaching, at which he needs to present the latest manufacturing and financial information for Tesla Motors. The board will take even greater interest in these details now that the stock price has crested the $150 mark.

Musk reaches for his smartphone to check the latest round of urgent text messages as he glances at the award for the Tesla Model S on his desk—2013 Motor Trend Car of the Year—and smiles. As a serial entrepreneur, he is chasing his dream: to leave a legacy. Musk has been described as "Henry Ford and Robert Oppenheimer in one person,"[1] as well as "Tony Stark, the eccentric inventor better known as Iron Man."[2] Indeed, Musk made a cameo appearance in *Iron Man 2.* He believes Tesla just might be the company through which he can leave his mark in the history books. However, with several pressing issues and three companies to run, can he find a way to make it all work?

As Musk attempts to prioritize all of the critical information that must be reviewed for the day ahead, he contemplates the many obstacles still in his path at Tesla Motors. Is Tesla the next great American car company? Can it disrupt the market with electric vehicles just as Japanese and Korean car companies did in the past with their high-quality, low-fuel-consumption combustion vehicles? What is the competition doing to compete with Tesla, and how will Tesla need to change or adjust its strategy accordingly? Can an electric car company really create a sustainable competitive advantage with a limited infrastructure? Is Tesla's business model sustainable? Most importantly, can Tesla scale production to meet demand for the Model S and its upcoming Model X while maintaining the same high quality and yet drive down costs? Or, should Musk seek to either sell to an established car company, or partner even more closely with one that already has an equity stake in Tesla?

As the time nears 2:18 a.m., Musk curls up on the sofa in his office and wonders, "What will the next few years bring for this company, and what should I do to ensure its success?"

Elon Musk: Engineer Entrepreneur Extraordinaire

In 1989, Elon Musk left his native South Africa at age 17 to avoid being conscripted into the army. Says Musk, "I don't have an issue with serving in the military per se, but serving in the South African army suppressing black people just didn't seem like a really good way to spend time."[3] He went to Canada and subsequently enrolled in Queen's University in 1990. After receiving a scholarship, Musk transferred to the University of Pennsylvania. He graduated in 1995 with bachelor's degrees in both economics and physics and then moved to California to pursue a PhD at Stanford University in applied physics and material sciences.[4]

After only two days, Musk left graduate school to found Zip2, an online provider of content publishing software for news organizations, with his brother, Kimbal Musk. Four years later, in 1999, computer maker Compaq acquired Zip2 for $341 million (and was in turn acquired by HP in 2002).

Not one to stand still, Elon Musk moved on to co-found PayPal, an online payment processor. In 2002, eBay acquired PayPal for $1.5 billion, netting Musk $175.5 million for his 11.7 percent share of the company. Although it was financially lucrative, Musk still harbors resentment about this deal. He feels that letting eBay acquire PayPal sold short the company's potential, dooming it to a future as a niche tool rather than a launch pad for a full-fledged, online financial institution.

Musk describes himself as an "engineer and entrepreneur who builds and operates companies to solve environmental, social and economic challenges."[5] He is now leading on three different fronts: electric cars, renewable energy, and space exploration. Two of his three ventures—SolarCity and SpaceX—seem to be doing well. SolarCity's goal is to become the Walmart of solar-panel installations. With 2,510 employees spread out over 10 states, it is the number-one provider of residential solar power in California, and growing fast.[6] SpaceX aims to send satellites into orbit at a quarter of the current cost. Since Musk took over engineering responsibilities, he has managed to launch rockets that reach outer space successfully. In May 2012, SpaceX's Dragon spacecraft attached to the International Space Station, exchanged cargo payloads, and returned safely to Earth. Until then, only governments had accomplished this technically challenging feat. Since October 2012, when it completed its first official mission, SpaceX has begun regular resupply missions to the International Space Station.[7]

Although crowned "2007 Entrepreneur of the Year" by *Inc.* magazine, Musk feels that his personal ambitions have not yet been fulfilled. Many in California's venture-capital and high-tech community view Elon Musk as someone who has good ideas and breathes life into risky ventures, but then fizzles out on them. He aims to prove them wrong. As a result, Musk's dreams for Tesla Motors, the California-based designer and manufacturer of electric vehicles, are big; he wants to leave a legacy through this company. Thus, after firing three CEOs in the last few years, Musk is now leading the company himself.

A Brief History of Tesla Motors

Tesla Motors (TSLA) was founded in 2003 in San Carlos, California, as an automobile company dedicated to developing electric vehicles. Co-founder Elon Musk was also one of the first investors, putting up $7 million initially, and later an additional $30 million.

Tesla Motors held a design contest for the styling of its first product: the Roadster, code-named "Dark Star." Lotus Cars, a British manufacturer, won the contest and jointly engineered and manufactured the new vehicle. Lotus was a natural partner for this project because of its experience and expertise in building its own line of sports and racing cars. In fact, the Tesla Roadster was modeled using the Lotus Elise as a template. The partners designed the Roadster's chassis using Lotus software tools and had it manufactured by the same Norwegian company that built the Elise.

In December 2006, *Time* magazine hailed the Tesla Roadster as the best invention of the year in the transportation category. In 2007, however, it became clear that sales were not enough to sustain business; the company was bleeding money. After combing through Tesla's financial situation, Musk found that Tesla was losing $50,000 on each car sold. As CEO, Martin Eberhard had led investors to believe that the manufacturing of the Roadster cost only $65,000 per car, which appeared to justify the $92,000 sticker price. In reality, Musk found that it cost Tesla $140,000 just for the parts, subassemblies, and supplies to make each vehicle, and that the Roadster could not even be built with Tesla's current tools. He also discovered major safety issues with the existing design. Completely taken aback by the messy state of affairs, Musk commented, "We should have just sent a $50,000 check to each customer and not bothered making the car."[8]

Consequently, Musk fired Martin Eberhard and took over the engineering himself. Almost every important system on the car, including the body, motor, power electronics, transmission, battery pack, and HVAC, had to be redesigned, retooled, or switched to a new supplier. Such dramatic changes were necessary to get the Roadster on the road at something close to the published performance and safety specifications, as well as to cut costs to make the Roadster profitable.[9]

Tesla Motors launched a completely redesigned Roadster in 2008 at a base price of $109,000.[10] By December 31, 2009, Tesla had 514 employees and had sold 937 Roadster models in 18 countries around the world. More than 1,200 additional people had put in deposits to reserve a Roadster, giving the company $70 million in interest-free loans. Three years later, on December 31, 2012, Tesla had sold more than 2,450 Roadsters.[11] The 2008 version of the Tesla Roadster had been discontinued and replaced with a new model, the Tesla Roadster 2, with an improved electric powertrain performance and lower production costs. The Roadster Sport, which accelerates from zero to 60 miles per hour in 3.7 seconds (faster than a Porsche 911 GT), was the next vehicle added to the pipeline.

Now, however, Tesla Motors has decided to discontinue production of the Roadster altogether after announcing the introduction of the Model S. In March 2009, Tesla introduced to the public an early prototype of the Model S family sedan. By year-end, Tesla had received approximately 2,000 customer reservations for the car, with a minimum down payment of $5,000 each. The prototype had turned into a premium sedan and garnered approximately 12,000 reservations by June 2012.[12]

Tesla manufactures the Model S in the Fremont, California, factory that it purchased from Toyota for $42 million in May 2010.[13] The car seats five adults, goes from zero to 60 in 4.4 seconds, and has a per-charge range of over 300 miles for the high-end version. As Musk described the electric car's efficiency and range on Tesla's blog, "With the 85 kWh Model S battery we set a goal of delivering a range greater than 300 miles using the 2-cycle EPA test procedure that we used with the Roadster. This is a goal that no electric vehicle (EV) in history had ever achieved. We are thrilled to say that we exceeded this goal."[14] One University of Central Florida senior researcher traveled more than 423 miles on a single charge in his Model S Signature model, which boasts the larger 85-kilowatt-hour battery.[15]

Deliveries of the Model S began on June 22, 2012, and positive feedback followed. As of December 2012, there were over 20,000 reservations for the vehicle, and Tesla was producing some 500 cars a week by the summer of 2013.[16] The base price of the Model S has been $52,400 (after a $7,500 tax deduction) since January 1, 2013.[17] The automobile magazine *Motor Trend* gave the Model S glowing endorsements, stating, "By any measure, the Tesla Model S is a truly remarkable automobile."[18] In an attempt to build on its success with the Model S, Tesla has begun work on a newly designed seven-seat electric vehicle, the Model X, which will combine the best features of an SUV with the benefits of a minivan. It plans to deliver the first Model X in 2014.[19]

Tesla's growing popularity and big plans continued to face scrutiny through 2012 because of its financial uncertainty. Tesla completed its IPO on June 29, 2010, the first IPO by an American automaker since Ford in 1956. On the first day of trading, Tesla's shares closed at $23.89 and generated $226.1 million for the company.[20] Despite this, in its first annual report, Tesla reported an operating loss of $146.8 million.[21] By the end of 2012, it reported total losses of more than $396 million (see Exhibit 1). However, in a letter to shareholders for the first quarter of 2013, Tesla announced its first profitable quarter in 10 years, with a GAAP profit of $11 million. Investors responded in kind to the black ink in Tesla's ledger, causing a surge in the stock price, and pushing Tesla's stock up over $150 per share on August 8, 2013 (see Exhibit 2). This rally continued despite a recall of 1,228 2013 Model S vehicles in June.[22] In the first-quarter shareholder letter, Elon Musk stated that Tesla's profit was attributable to operating more efficiently than ever before:

> As our manufacturing processes stabilized and our supply chain continued to mature, we turned our attention to improving execution. In the process, we reduced the hours required to build a car by almost 40% from December to March.

> We also improved our inventory management. During Q1, raw materials declined by almost 26%, while unit production increased 80%. Better inventory management contributed over $30 million in cash and reduced our logistics costs during the quarter.[23]

The U.S. Automotive Industry

The Big Three automakers—GM, Ford, and Chrysler—have dominated the U.S. automotive industry for decades (see Exhibit 3). GM was once the leading U.S. carmaker, with market share of over 50 percent in 1962. By 2009, GM's market share had eroded to less than 20 percent, while the market share of the Big Three *combined* dropped below 50 percent for the first time ever.[24] GM and Chrysler filed for bankruptcy, while Ford was fighting hard to become profitable again. What had caused their decline?

In the 1990s, the Big Three shifted resources away from mid-size and compact cars to lead the "SUV craze." They built their business models around the assumptions that gas prices would remain low for the foreseeable future, and that Americans would continue to prefer big trucks and SUVs. For as long as these assumptions held true, the strategy was quite profitable; pickup trucks and SUVs provided the highest margins of any vehicle class. In fact, the Ford F-150 pickup truck remains the most-sold vehicle in the United States of all time. For a while, the Hummer 1 (with gas mileage of 7 mpg) was one of GM's most profitable vehicles.

However, when SUV sales peaked in 2004 and started to decline, the Big Three were slow to detect and adapt to the shift in customer purchase patterns. Then, in the wake of the 2008 financial crisis, U.S. car sales hit a historic low of some 11 million vehicles, down from 18 million in 2000. Meanwhile, the price of a gallon of gas rose to over $4 in the summer of 2008, up from about $2 in 2005 (see Exhibit 4). While all car segments experienced a dramatic reduction in demand, trucks and SUVs were hit particularly hard. By summer 2013, gas prices had fallen to an average of $3.59.[25]

GM

The Big Three found it particularly difficult to compete in this leaner financial environment due to their higher cost structure. Unlike their foreign counterparts, U.S. companies had to cover long-term legacy costs for employee health care and pensions. GM was particularly vulnerable in this regard. At one point, GM paid the *full cost* of health insurance premiums for all of its employees and their dependents, as well as GM retirees and survivors. When U.S. health care costs rose precipitously in the latter part of the 20th century, most of these legacy plans ended up chronically underfunded. Taking steps such as providing retirement packages to older workers and negotiating agreements with unions to transfer pension dues to an independent trust helped, but fell far short of solving GM's financial woes.

Compounding the company's financial situation further, GM had also made large concessions to the United Auto Workers (UAW) union, driving up hourly wages and benefits. For example, laid-off autoworkers could await re-employment while enjoying almost full wages at so-called *job banks.* GM was caught in a classic catch-22. Given the costs of unionized labor, GM was unable to make money on small, fuel-efficient cars without heavy government subsidies through tax incentives.[26] Yet because the UAW had a monopoly over GM's labor force, GM could not take appropriate actions to reduce its labor expenses, either by laying off workers or by negotiating more competitive wages. Bankruptcy was inevitable.

The GM that reemerged 60 days after the bankruptcy filing had a significantly restructured balance sheet and four fewer brands (Hummer, Pontiac, Saab, and Saturn). In order to "bail out" the firm, the U.S. government provided close to $58 billion under the Troubled Asset Relief Program (TARP), making it the de facto owner of the company. In December 2012, GM announced that it was going to spend $5.5 billion to buy back a large portion

of its stock that was being held by the U.S. Treasury, reducing the U.S. government's ownership in the company from 26.5 percent to 19 percent. GM intends to pay off the remaining balance of the bailout loan by the first quarter of 2014.[27]

CHRYSLER

In 1998, German car manufacturer Daimler paid $36 billion to acquire a troubled Chrysler Corporation. Touted by some as a "merger of equals," the true nature of the deal became apparent when several senior U.S. managers either left or were fired and then replaced by Daimler managers. Their decision to retire the Plymouth brand fueled the brewing mistrust even more.[28] Theoretically, the acquisition gave Chrysler entry into European markets, created a larger, complementary product line (Chrysler sold SUVs, minivans, and mass-market cars, while Daimler specialized in luxury sedans and sports cars), and provided both companies with increased market power.

However, the management cultures of the two companies clashed, and DaimlerChrysler never achieved the anticipated synergies.[29] Ultimately deciding it was better off on its own, Daimler sold 80.1 percent of Chrysler to Cerberus Capital for $7.4 billion in August 2007. Cerberus took Chrysler private in a leveraged buyout, hoping to restructure the company away from the pressure of public financial reporting. Unfortunately, Chrysler's problems were too big for even Cerberus to fix, and the company declared Chapter 11 bankruptcy on April 30, 2009.

At this point, the federal government intervened, paying $6.6 billion to finance the company's restructuring into the "New Chrysler." Of that amount, 55 percent was owned by a pension fund and 25 percent by the Italian carmaker Fiat, with the U.S. and Canadian governments holding minority stakes.[30,31] Fiat provided Chrysler with a platform for smaller, more fuel-efficient cars and access to Fiat's global distribution network. Chrysler hoped to realize cost savings in design, engineering, manufacturing, purchasing, and marketing, while Fiat gained significant access to the U.S. auto market.

FORD

Ford, on the other hand, had raised $24.5 billion in capital by mortgaging almost all of its assets during the height of the financial bubble, giving it access to a large line of credit.[32] While supporting GM's and Chrysler's requests for a government bailout, Ford did not request, nor did it receive, any government funding. With attractive new models, such as the Ford Focus and the redesigned Ford Explorer, the company is currently experiencing a renaissance.

In October 2012, Ford posted a $1.6 billion third-quarter profit, a consequence of the successful implementation of its strategy of charging more for its vehicles while spending less to develop them. According to its chief financial officer, Robert Shanks, "If you go back 5 or 10 years ago, we had very good margins on our trucks . . . we did OK on larger SUVs . . . we didn't do particularly well on the large cars and we just lost massive amounts of money on the other cars." Now, Shanks noted, Ford makes money on its small cars as well as its large vehicles. "That is a huge change from where we were."[33]

FOREIGN COMPETITION

Since the first oil price shock in 1973–1974, foreign car manufacturers have made steady inroads into the U.S. market. Investing more in research and development, compared with the Big Three, German, Japanese, and Korean carmakers were perceived to offer vehicles of higher quality, more advanced engineering, and better fuel efficiency. Because they were not burdened with health care and pension costs, the foreign companies could also make and sell their vehicles at lower prices (leading to increased sales and/or higher margins). By November 2012, Japanese automakers Toyota and Honda were number three and five in sales volume in the United States, respectively. Nissan (Japan), Hyundai (Korea), and Kia (Korea) have also become strong competitors in the U.S. market.[34]

Japanese carmakers Toyota and Honda have long been considered the leaders in producing high-quality, fuel-efficient cars. Toyota has always been Japan's largest automaker, and in early 2009, it overtook perennial world leader GM in both production and sales. Since then, GM and Toyota have exchanged positions several times for the top spot in total worldwide sales. Honda is Japan's second-largest automaker and ranks fifth in the world, behind GM, Toyota, Volkswagen, and Ford. Due to Voluntary Export Restraints (VERs) enacted by the Reagan administration in 1981, Japanese companies have invested heavily in U.S. production facilities. Japanese plants are typically non-unionized and are located in the southern United States, where the costs of living are lower, away from their "northern" domestic competitors. Along with philanthropy, lobbying efforts, and sharing technology, establishing U.S. production facilities was a significant step in improving public relations and decreasing their liability of foreignness.

Developmentally, Korean car manufacturers today occupy a position in the U.S. automobile market similar to that of the Japanese companies in the 1980s. Viewed as the cheaper, fuel-efficient alternatives to American, Japanese, and European cars, they are gaining more widespread recognition and acceptance among American car buyers. Some experts argue that Hyundai is already on par in quality with Toyota and Honda (see Exhibit 5).

The three largest German carmakers—Daimler, BMW, and Volkswagen—each hold between 2 and 3 percent of the U.S. market. Porsche, a wholly owned subsidiary of Volkswagen since 2012, is a strong niche player in the luxury sports vehicle segment, while Audi, a wholly owned subsidiary of Volkswagen since 1966, has gained a strong reputation for its mid-size luxury sedans and SUVs. Like their Japanese counterparts, German car manufacturers have gained market share steadily over the last several years through perceived superior engineering and styling capabilities. As fuel prices have increased, demand for German vehicles has also risen, since they combine sportiness and luxury with fuel efficiency.

Alternative Propulsion for Cars

The oil embargoes of the 1970s first highlighted the need for smaller, more fuel-efficient vehicles. Concerned about U.S. reliance on foreign oil, Congress voted to append Title V, "Improving Automotive Efficiency," to the Motor Vehicle Information and Cost Savings Act. This legislation established CAFE (Corporate Average Fuel Economy) standards for passenger cars and light trucks, and set a goal of doubling new-car fuel economy by model year 1985.[35]

In 1990, the California Air Resource Board (CARB) passed a mandate for the introduction of zero emission vehicles (ZEVs). The act specified that 2 percent of the vehicles produced for sale in California had to have zero emissions by 1998, increasing to 5 percent in 2001 and 10 percent in 2003. Subsequent amendments dropped the 1998 and 2001 requirements, but left the 10 percent value for 2003 in place while also allowing credits for partial-ZEV cars.[36]

Importantly, the ZEV mandate is credited with stimulating increased research and development of the electric-car prototype. The first electric production car EV1 (made by GM) came to market in 1996 in California and Arizona as a lease-only vehicle. Competitors Toyota and Honda quickly followed suit with their own EV cars. However, most of these early models were discontinued after automakers successfully challenged the mandate in Federal District Court in 2002, winning significant concessions and delays from the CARB. In hindsight, former GM Chairman and CEO Rick Wagoner said that the worst decision of his tenure at GM was "axing the EV1 electric-car program and not putting the right resources into hybrids. It didn't affect profitability, but it did affect image."[37] GM R&D chief Larry Burns now wishes GM had not killed the EV1 prototype his engineers had on the road over a decade ago: "If we could turn back the hands of time," says Burns, "we could have had the Chevy Volt 10 years earlier."[38]

The next major development occurred in 2003, when the U.S. government supported investments of $1.3 billion in research into hydrogen-powered vehicles. Ironically, around this same time Congress also passed accelerated depreciation tax breaks of up to $100,000 for buyers of gas-guzzling SUVs, compared with $4,000 for buyers of

electric cars, with major unintended consequences. Although the $100,000 tax break was intended for commercial trucks, as written, it included all trucks. This allowed GM to push sales of the original Hummer 1, with a sticker price of $125,000 and a 7-mile-per-gallon fuel consumption.

Recently, alternative energy sources have been thrust into the limelight again due to growing environmental concerns and an upsurge in crude-oil prices. This time, car manufacturers have responded by making significant investments in the research and development of various competing energy technologies (see Exhibit 6). A classic standards battle seems to be emerging, with the winner likely to create a new paradigm for personal transportation. Electricity, hydrogen, biodiesel, compressed natural gas, and ethanol are the most common alternatives being considered as replacements for fossil fuels. Meanwhile, others predict that the internal combustion engine will be around for another 50 to 100 years, at least in hybrid vehicles. In 2009, however, CAFE standards were further raised, requiring an average fuel economy of 35.5 miles per gallon for model years 2012–2016.

There has been a steady increase in the number of alternative fuel vehicles since 1995 (see Exhibit 7). As of 2010, there were almost 1 million in use in the U.S., and this trend should continue into the future as more and more manufacturers focus their efforts on this initiative.

BATTERY ELECTRIC VEHICLES

There are two basic types of electric vehicles. One is the "pure" electric vehicle (sometimes referred to as the battery electric vehicle or BEV), which uses only batteries to supply the electric energy needed for propulsion. Leveraging the fact that electric motors can also act as generators, electric vehicles utilize regenerative braking to save a significant portion of the energy expended during acceleration, thus increasing the energy efficiency of the vehicle. In addition, pure electric vehicles have a high torque over a larger range of speeds during acceleration compared with internal combustion engines. For example, the Tesla Roadster was rated at 288 horsepower (hp) and accelerated faster than a 911 Porsche GT. Running and servicing costs of the electric car are also much lower than its gasoline-based counterparts; Tesla Motors estimated that the cost per mile driven with the Roadster was just $0.02. This is because electric motors and gearboxes have relatively few moving pieces, compared with the hundreds of precision-engineered parts necessary for an internal combustion engine. BEVs are usually very quiet and do not emit any exhaust gases.

The major disadvantage of BEVs is the battery. It is the most expensive part of the car, is subject to deterioration over its lifetime, is heavy, requires long charging times, and offers a very limited energy-to-weight ratio. This low ratio significantly restricts the driving range of electric vehicles. Finding an economic balance of range versus performance, battery capacity versus weight, and battery type versus cost therefore challenges every BEV manufacturer. A nickel-metal hydride (NiMH) battery typically lasts the life of the vehicle, but the range tends to be less than 200 miles, and it takes hours to recharge the battery. Newer BEVs equipped with lithium-ion batteries provide 250 to 300 miles of range per charge. Many experts believe that battery-production problems could be the limiting factor for the electric-car industry. "Batteries are absolutely the No. 1 constraint for electric cars," says Mark Duvall, a researcher at the Electric Power Research Institute in Palo Alto, California, a utility-funded research organization. "It's also the single-most expensive component right now."[39]

To address this technological gap, a number of small U.S. firms focus their R&D on lithium-ion batteries with the hope of supplying automakers. Both Boston Power Co., which supplies batteries for Hewlett-Packard laptops, and Valence Technology Corp., which makes batteries for the Segway scooter, plan to expand into making automotive batteries. At the same time, Chinese and Japanese firms, such as BYD Motors, Panasonic, Sony, and Sanyo Electric, that already have expertise making lithium-ion batteries, are jockeying for a share of this emerging industry. Former chairman Andy Grove is even pushing Intel to manufacture advanced batteries for plug-in electric cars.[40] According to Mr. Grove, unless U.S. firms get serious about developing a cutting-edge battery soon, the nation may achieve a Pyrrhic victory, breaking an addiction to imported oil through the use of electric cars but replacing it with a dependence on imported batteries.

Despite battery constraints, car manufacturers, including the Big Three and foreign automakers, have introduced their first electric-only vehicles to the market. Chrysler founded its ENVI division in 2007 to create electric-drive vehicles and introduced its first "production intent" prototype one year later: an electric-only Dodge EV sports car. However, after Fiat took over Chrysler, the company disbanded the ENVI electric car division and dropped its models from future product plans but has recently introduced the Fiat 500e that has a range of 87 miles per charge.[41] In December 2012, Ford introduced the Ford Focus electric vehicle into the U.S. market at a starting price of $39,200 and a range of 76 miles.[42] General Motors will add an electric mini-car called the Spark in 2014 ($19,185 and expected to go 82 miles on a single charge) to complement its Volt plug-in hybrid electric compact ($26,685).

Among Japanese carmakers, the Nissan Leaf is a compact five-door, five-passenger hatchback, with an all-electric range of 73 miles on a single charge in city driving, and an estimated fuel economy of at least 99 miles per gallon gasoline equivalent. The Leaf is manufactured at Nissan's Smyrna plant in Tennessee. The 2013 model is listed at an estimated sticker price of roughly $21,300 after subsidies and tax credits are applied.[43] Mitsubishi currently sells its i-MiEV (Mitsubishi innovative Electric Vehicle) in the U.S. The i-MiEV will run for approximately 62 miles between charges and has an estimated fuel economy of 112 miles per gallon equivalent.[44] In addition, several smaller European companies have introduced future concept cars. Monaco-based Venturi has one high-end electric sports car in production, the Fétish, which sells for about $400,000 but is not intended for mass markets.[45]

Battery electric vehicles are appearing with increasing variety in range options and pricing points. The current gamut of vehicles has driving ranges between 62 and 265 miles per charge, with prices ranging between $16,395 and nearly $95,000 (see Exhibit 8), making the cost for peace of mind on the road very expensive for the common person.

PLUG-IN HYBRID ELECTRIC VEHICLES

The other type of electric vehicle relies on hybrid propulsion, which combines an electric motor with an internal combustion engine. Hybrid electric vehicles (HEVs) have all the advantages of pure electric vehicles, but avoid the range-restriction problem through the use of a gasoline-powered internal combustion engine. Plug-in hybrid electric vehicles (PHEVs) contain a battery that stores electricity for the electric motor and can be recharged. Since the battery shares the propulsion load, hybrid engines are significantly smaller than their traditional gasoline counterparts, reducing vehicle weight and cost share. PHEVs can reduce air pollution, dependence on petroleum, and greenhouse-gas emissions. Other benefits include improved national energy security, fewer fill-ups at gas stations, the convenience of home recharging, opportunities to provide emergency backup power in the home, and vehicle-to-grid applications.

Elon Musk is a strong opponent of hybrid vehicles. He argues that HEVs combine the disadvantages of both electric and gasoline-powered vehicles, negating the advantages that each type offers. He argues that hybrids are "bad electric cars" because they must carry around an additional engine and drive train, adding weight, cost, and additional parts to maintain and repair.[46] He criticizes the combustion engines as too small, "anemic," and inherently less efficient than full-size engines. Moreover, the combination of these technologies in a single vehicle adds to the technological complexity, which increases cost, error rates, and maintenance efforts. Hybrid supporters, on the other hand, are optimistic that these disadvantages can be mitigated through continued research and development.

Despite their shortcomings, sales of hybrid vehicles in the United States increased steadily from 1999 through 2007, and then started to decline in conjunction with overall sales of automobiles due to the recession. As car sales have climbed again since 2011, hybrid sales have also experienced gains. Toyota sold the majority of the early hybrids, introducing the Prius in 2000, only one year after the first commercial HEV, the Honda Insight, entered the market. In September 2012, Toyota estimated that "sales of hybrid models worldwide will likely top 1 million

this year and every year through 2015."[47] In line with this projection, Toyota plans to roll out 21 new or redesigned hybrid vehicles by the end of 2015.

American manufacturers have been relatively slow to follow Toyota's lead in hybrid technologies. At the 2009 North American International Auto Show in Detroit, Chrysler unveiled the 200C EV Concept minivan ("Electric Town and Country") and the Jeep Patriot EV, both range-extended (electric and gas engine) vehicles. As with Chrysler's pure electric sports car prototype, however, these models were discontinued when Fiat shut down Chrysler's ENVI division and have been supplanted by Fiat's 500e effort. By 2012, Ford had introduced two hybrid car models into the U.S. market: the Ford C-Max Hybrid priced at approximately $25,000 and the Ford Fusion Hybrid priced at $23,000.

More than 10 years after the Toyota Prius first debuted, GM is seeking to challenge the Prius' market dominance with its Chevrolet Volt, first introduced in 2007. The Volt is a so-called plug-in hybrid, enabling the Volt to achieve a fuel economy of 50 miles per U.S. gallon. The Volt has a long way to go before it can become a serious contender for the mass hybrid market, however. Not only does it come with a sticker price of about $40,000, compared with $23,000 for the Prius,[48] but also the early model Volt experienced some serious technical problems. It needs to be charged for six hours to gain the necessary battery power for a single 40-mile drive. The Volt's gas engine extends its range beyond the 40-mile battery limit, but this introduces another issue: The gas tank must be drained periodically in order to keep the gasoline from going bad.

Even worse, GM is unlikely to recoup its R&D expenses, causing some analysts to charge that the Volt is nothing more than a "show car" to demonstrate that GM understands the trends in the market and is investing in next-generation vehicle technologies.[49] In fact, GM had to halt production of the Volt for several weeks in 2012 due to weak demand for the vehicle. There is also strong speculation that GM is losing money on every Volt sold, partly due to low-priced leasing packages and price reductions that were intended to attract customers and drive sales.[50,51]

A potential threat to Tesla's business is BYD Motors, a Chinese startup, which is already selling plug-in electric hybrids in China. As the first Chinese car manufacturer poised to break into Western markets, BYD has attracted the attention of Warren Buffett, who invested some $230 million for a 10 percent equity stake in the company. BYD has an advantage in that it started as a battery company and has developed lithium iron phosphate batteries, which permit cars to run 250 miles on a single three-hour charge.[52,53] The sticker price of BYD cars is anticipated to be about one-half that of the price for the Chevrolet Volt. As of August 2012, it still did not have a model that was readily available in the U.S market and is years behind schedule in selling its vehicle abroad.[54]

In the luxury segment, Quantum Technologies and Fisker Coachbuild, LLC, announced the launch of a joint venture (Fisker Automotive) in September 2007. Fisker Automotive launched a luxury plug-in hybrid, the Fisker Karma, in 2011 with an initial price of $110,000, but halted production in July 2012 due to financial problems. In December 2012, the company announced that it had hired an investment bank to help raise funds for the cash-strapped company. It is also actively seeking partners in China and parts of Europe, where the company feels that there is a stronger interest in electric cars. Fisker Automotive had hoped to find new capital, possibly from the sale of the company.[55] In April 2013, Fisker ended up laying off 75 percent of its employees and began the process of filing for bankruptcy.[56]

Despite the problems it has encountered with the Chevrolet Volt, General Motors also plans to enter the luxury plug-in hybrid market with the introduction of the Cadillac ELR. It is expected to be available in the U.S. in 2014 and will be manufactured in Michigan in the same plant as the Volt.

BIOFUELS AND NATURAL GAS

In addition to electricity, researchers are exploring ethanol and natural gas as alternative fuels for automobile propulsion systems. Ethanol is a biofuel easily derived from natural sugars (starch) in crops such as sugar cane

and corn. With a small amount of redesign, gasoline-powered vehicles can run on ethanol concentrations as high as 85 percent (E85).

While biofuels do not contribute to carbon dioxide emissions, they are still not free of criticism. Some believe that the use of ethanol as a source of fuel is responsible for an increase in food prices.[57] Not only must huge swaths of land be devoted to specific crops, but also the crops that are grown must go to make fuel instead of feeding people or farm animals. Critics also argue that growing the crops requires more energy than the fuel they produce, making the process inherently inefficient. Further, the use of crops for fuels is highly politicized. In the United States, ethanol derived from corn or sugar cane can be competitive in price only because of government subsidies. Other countries, such as Brazil, can produce biofuels much more cost effectively due to the ready availability of an unskilled labor force, but the U.S. government has barred these cheaper Brazilian imports from entering the U.S. market in order to protect domestic producers. Factoring in these subsidies and trade barriers makes biofuels a net-loss-incurring business.[58]

Biodiesel, produced from oilseed, has been a more popular substitute in European countries, where gasoline is four times more expensive than in the United States. Although biodiesel is commercially available in most oilseed-producing states, it is somewhat more expensive than fossil diesel. In addition, biodiesel has lower energy density than either fossil diesel or gasoline, resulting in decreased fuel economy. Nevertheless, biodiesel engines are considered to be more environmentally friendly than gasoline engines because they do not emit carbon dioxide.

High-pressure compressed natural gas, composed mainly of methane, can also be utilized in place of gasoline to fuel normal combustion engines. The combustion of methane produces the lowest amount of carbon dioxide of all fossil fuels. Cars can be retrofitted to run on compressed natural gas as well as gasoline, allowing the driver to alternate between fuel sources during operation.

HYDROGEN AND FUEL CELLS

Hydrogen may serve as an alternative fuel through one of two methods: combustion or fuel-cell conversion. In combustion, the hydrogen is "burned" in engines in fundamentally the same way as gasoline. In fuel-cell conversion, the hydrogen is turned into electricity through fuel cells, which then power electric motors. German carmakers Volkswagen and Audi have started their own research departments on fuel cells, while Mercedes plans to start a limited 200-car series of its B-class model based on fuel-cell technology.

One primary area of ongoing research aims to increase the range of hydrogen vehicles while reducing the weight, energy consumption, and complexity of the storage systems. The major disadvantage for both the combustion and fuel-cell methods is that there is no infrastructure to supply and store hydrogen in mass quantities. Building such infrastructure will require not only the automakers, but also governments, to make commitments to hydrogen technology. As a result, some experts believe it will be some time before hydrogen cars are economically viable.[59] Still, major manufacturers have formed partnerships for researching fuel-cell technology. In the summer of 2013, GM and Honda decided to work together to create the technology and infrastructure for refueling fuel-cell-powered vehicles. Nissan and Ford are working together to develop fuel-cell-powered vehicles as early as 2017, while Toyota and BMW are collaborating on similar projects.[60]

QUEST FOR A STANDARD

Although many alternative fuel sources are currently in production and development, no overall industry standard has yet emerged. Companies that have invested considerable sums of money in R&D continue to push their technology as the best. Wary of betting on the wrong technology, many car manufacturers have opted to sit on the sidelines until a clear winner emerges, which slows the pace of progress.

Meanwhile, determining a new standard for fuel and propulsion systems is only the first step toward reducing our reliance on fossil fuels. Just as we have multiple oil companies, nationwide systems of gas stations, and

pipelines to ship gasoline from the refineries to the pump, any alternative energy will require its own unique infrastructure. At the same time, standardized supporting technologies and peripheral devices must be developed so that the new vehicles can be "refueled," repaired, and serviced anywhere they travel. We take for granted that the same gas pump nozzle fits into the tank of a Honda minivan and a Mini Cooper, and that the same grade of gasoline is available no matter where we stop to refuel. Similarly, windshield wiper fluid, engine oil, and antifreeze can be purchased without regard for make or model. These supporting "details" are perhaps the biggest obstacle that has kept any of the new alternative propulsion technologies from being fully embraced.

Electric Car Infrastructure

There have been four major types of infrastructures under development to extend the range and decrease the charging times of pure electric vehicles. First, the U.S. National Institute of Standards and Technology and the Federal Energy Regulatory Commission are heavily involved in the definition of future smart-grid standards.[61] The U.S. government currently offers economic incentives to encourage electric vehicle ownership, and realizes that an electric infrastructure must be in place to meet the needs of on-the-go Americans. Smart grids are electricity networks that utilize two-way digital metering, sensing, monitoring, and control technologies to improve electricity production, transmission, distribution, and consumption. By providing information about grid conditions to system users, operators, and automated devices, the smart grid enables dynamic responses to energy needs, which in turn saves energy, reduces costs, and increases reliability. Once installed nationwide, the smart grid could also provide a means of recharging batteries for electric-powered vehicles.

Better Place, a California-based electric vehicle services provider, attempted another infrastructure type. Shai Agassi, the Israeli-American founder of Better Place, likened the firm's model to that of a telecom provider, from whom users buy charged-battery minutes. If the service contract is large enough, Better Place might even provide a "free" or highly subsidized car itself, much like telecom providers provide discounted cell phones when customers sign two-year service agreements.[62] In March 2008, Deutsche Bank analysts stated that the company's approach could mark a "paradigm shift" that causes a "massive disruption" to the auto industry, and that Better Place has "the potential to eliminate the gasoline engine altogether."[63]

However, major German carmakers (which wield considerable market power) are skeptical of Agassi's model. They claim that Better Place's business plan stifles creative design freedom by introducing too many constraints on the car's body. Further, there are unresolved legal issues with battery ownership between the station operator, Better Place, and car owners. As forecasted by the skeptical German automakers, Agassi's company eventually filed for bankruptcy and started liquidating assets in July 2013 due to the slow-paced development of the electric car market.[64] Since Better Place's demise, it has been up to Tesla to make the push for a nationwide network of electric vehicle service stations.

A group of scientists at the Fraunhofer Institute for Chemical Technology in Pfinztal, Germany, investigated another infrastructure alternative. This technology involves a flushable, liquid electrolyte for electric car batteries;[65] draining the used electrolyte and refilling the battery with charged electrolyte would recharge batteries. The time for such a recharge would be in line with current times for filling a car with gasoline. The electrolyte could be recharged locally, possibly using wind or solar energy, in contrast to the costs of transporting other types of fuel sources cross-country. As a result, the German approach would reduce the carbon dioxide footprint for electric cars.

A fourth alternative, specifically for Tesla vehicles, is emerging, and unsurprisingly, Elon Musk is driving the initiative. Tesla is prepared to build charging stations around the U.S. so that drivers can drive across the country for free. Tesla developed and built the start of this network largely in secret, rolling out stations in the California towns of Folsom, Gilroy, Harris Ranch, Barstow, Tejon Ranch, and Los Angeles. Tesla intends to build dozens more, likely beginning in the northeast United States, and promises to have more than 100 stations

throughout the country by 2015 (see Exhibit 9). The company has stated that the goal of the infrastructure is to enable "fast, purely electric travel from Vancouver to San Diego, Miami to Montreal and Los Angeles to New York."[66]

If you drive a Tesla, that is. So far, the charging stations are compatible only with properly equipped Model S vehicles, which raises the question of whether or not Musk should be spending millions of dollars building an infrastructure that only one car on the road can benefit from on a daily basis. Tesla's "supercharging" stations are capable of charging a battery up to a 200-mile range in 30 minutes, free of charge. Realizing that this is still much slower than pumping gas, Musk prepared his own public marketing stunt. At a live event, he publicly demonstrated the replacement of two Model S battery packs via a robotic system in the time it took a Tesla employee to pump 20 gallons of gas. Thus, he proved, at least in his mind and the mind of many Tesla enthusiasts, that electric cars have the potential to refuel faster than their gas-powered brethren. Eventually, supercharging stations will be equipped with this battery swapping system. Although the service would cost Tesla-owners between $60 and $80 per swap, it is comparable to the cost of pumping a full tank of gas.[67]

Strategic Partnerships

Tesla has managed to strike some important deals with big players in the automobile industry. In 2009, German automotive engineering powerhouse Daimler purchased a nearly 10 percent equity stake in Tesla, worth an estimated $50 million.[68] Musk and his team wowed the skeptical Daimler executives by modifying an off-the-shelf Daimler Smart car into an all-electric vehicle in only six weeks.[69] The collaboration deepened in February 2012, when Tesla released the following statement: "We are also pleased to announce the start of a development program with Daimler for a new Mercedes-Benz vehicle with a full Tesla powertrain."[70]

Daimler isn't the only traditional automaker to take an interest in Tesla. After Musk took the company public in 2010, Toyota bought $50 million (roughly 3 percent) of Tesla's stock.[71] With this deal, Tesla got ownership of the New United Motor Manufacturing, Inc. (NUMMI), automotive factory, which it later purchased outright, in Fremont, California. NUMMI was initially set up as a joint venture between Toyota and GM. GM withdrew from NUMMI as part of its bankruptcy reorganization in 2009. Tesla announced in October 2010 that it would go into a further partnership with Toyota by providing parts that will power the electric version of Toyota's crossover SUV, the RAV4.[72]

In addition, Tesla managed to bring Panasonic, one of the world's electronic giants, on board. Panasonic's aim is to combine its experience in battery technology with Tesla's capabilities in electric powertrain development. The goal for Panasonic is to become the number-one Green Innovation Company in the electronics industry by 2018, the 100th anniversary of its founding.[73]

International Expansion

At the same time that Tesla was pursuing strategic relationships with leading electronic and automotive companies, it started to expand its network of company-owned stores. Previously, all sales had been conducted either via the phone or Internet or in person at corporate events or company headquarters. By December 2012, Tesla had opened 24 sales locations throughout the U.S. and Canada, 13 stores in Europe, and 3 in Asia. The company targeted major metropolitan areas, including Chicago, New York, Los Angeles, London, Munich, Madrid, Tokyo, Hong Kong, and Sydney (Australia). Tesla anticipates establishing nearly 50 stores worldwide over the next several years, at a cost of $5 to $10 million annually.

To differentiate itself from its competitors and provide a superior customer experience, Tesla has opted not to create franchised dealers, but instead maintains all sales and service operations in-house. The company also created a wholly owned subsidiary, Tesla Motors Leasing Inc., to provide a leasing alternative to its customers starting in 2010.[74]

Price Pressure

Importantly, a study conducted by Nielsen found that, in the United States, 72 percent of people polled have considered buying or would buy an electric vehicle. However, 65 percent of Americans would not pay more for an electric vehicle than for traditional car models. Of those who said they would be ready to pay more, most were willing to pay no more than an additional $1,000 to $5,000.[75] Thus, electric vehicles will need to compete on price, and not on technology alone. To bring down unit costs, however, electric car manufacturers like Tesla must be able to scale production and thus must sell more units. Conventional wisdom in the industry holds that a car manufacturer must produce at least 1 million units on a given platform to be price competitive.

The contents of the Nielsen report may spell trouble for Musk's second generation of electric vehicles, the Model S. Tesla delivered approximately 2,650 Model S vehicles in 2012, just a little over half of what it projected, but it planned to deliver an additional 21,000 by the end of 2013.[76] Buyers have the option to purchase a model with either a 230-mile or 300-mile battery capacity. The 230-mile edition sells for $63,570 (which includes a $7,500 tax credit), and the 300-mile model sells for $73,570 (including the tax credit). In addition, Tesla offers the Model S Performance edition with a 300-mile range that boasts additional upgrades to the interior, suspension, and wheels. The Performance edition is priced at $83,570 (including the tax credit). Exhibit 10 shows the specifications for all three models. While the Model S costs less than the Roadster did, all three versions still retail at a premium compared to current electric vehicles, such as the Nissan Leaf.

Critics are skeptical that Tesla can get its prices down to a competitive level, produce the Model S on time, and have it perform as promised. Moreover, due to the relatively low price of gas in the U.S. compared to Europe, where the price of a gallon of regular gas hovers around $10, the economic incentive to buy and maintain an electric vehicle is not there at this point. Tesla will launch its Model X SUV and a cheaper model in 2014 in an attempt to attract more regular buyers. Still, it remains to be seen whether the price point and feature set appeal to the regular buyer.[77]

Manufacturing Challenges

Tesla Motors' original production at the former NUMMI plant started with five Model S vehicles manufactured per month, but has climbed in a year's time to 500 vehicles produced per month. Musk intends to eventually reach the NUMMI plant's 500-million production capacity. The discontinuation of the Roadster and the low-end version of the Model S help with increasing production capacity. However, as mentioned earlier, Tesla intends to launch a Model X in 2014. Adding another model to the production line potentially increases demand as well as the complexity of manufacturing.

Musk's next manufacturing challenge is to reduce the cost to produce a vehicle. According to the Nielsen report mentioned earlier, many buyers are interested in all-electric vehicles but are much more price sensitive than they are willing to buy into the new technology. One option on the table is to move some manufacturing overseas closer to new markets and where labor costs are lower. These facilities could also serve to grow capacity and provide a means to expand into other global markets such as Asia and Europe.[78] Another plan to reduce costs is to share a few common parts with other manufacturers instead of building *their* own tooling for *their* own custom parts.[79]

Another manufacturing challenge facing Musk is how to maintain the high-quality standard cited in *Consumer Reports*' glowing review of the Model S and its sterling reputation as Motor Trend's 2013 Car of the Year. With increased production rates and the introduction of another product line, Tesla must carefully design and implement new facilities and processes that will meet the standards set by the 2012 Model S. This is a very real threat to Tesla's brand, as early adopters suffered a few software glitches that kept the door handles, which

retract into the body when not being used, from becoming accessible when the owner wanted to get into the car. While the early adopters were willing to tolerate these types of glitches, the mass market would be much less sympathetic.

Tesla's manufacturing challenges are punctuated by the expectations set by its stock price of $156 on August 8, 2013. As a comparison, Tesla's market cap was $13 billion on July 15, which made it roughly the size of Mazda Motors, which is expected to sell 1.3 million cars a year.[80] Tesla is producing only 21,000 for the same market expectations. In order for Musk to justify the stock price in the long run, he must overcome the manufacturing challenges facing his automotive company.

Tesla Motors: Strategic Choices

Despite its progress over the last several years, Tesla still faces a serious laundry list of problems. Consumers are still reluctant to invest in all-electric cars, especially with so many other alternative technologies vying for market dominance. The infrastructure is not yet ready to support widespread use of electric vehicles, so buying one comes with significant inconvenience. No all-electric car has proven to be even a quasi-standard, with the result that any investment in an electric vehicle could backfire in the long term. Also, not enough models are available to enable consumers to make an educated selection, especially compared to the number of hybrid vehicles available.

Meanwhile, the gasoline-powered car industry keeps chugging along. The 2009 Car Allowance Rebate System (CARS) program (commonly referred to as "Cash for Clunkers") announced by the U.S. government in 2009 did not exactly help reduce sales of traditional gas-powered vehicles. According to the U.S. Department of Transportation, about 700,000 cars were exchanged for newer, more fuel-efficient models, which will remain on the roads for the next 10 to 15 years.[81]

In addition, the issue of Tesla's cash flow weighs heavily. It continues to spend a great deal of money. By year-end 2012, Tesla's losses totaled almost $392 million. Questions remain: Will Tesla be able to make a profit? When? Does Tesla have a sustainable business model to ensure long-term success? Or, would it better to strengthen ties with one of its partners?

Finally, in early 2013, Tesla had to deal with two negative news articles about the Model S in *The New York Times.* The first article detailed the experience of a father-and-son team in Florida who, in the hopes of winning a Tesla-sponsored contest, attempted to be the first to drive the Model S at least 400 miles on a single charge. The team was able to drive the vehicle 423.5 miles, but it took them 17 hours at an average speed of approximately 25 mph to do so.[82] The second article recounted the journey of staff writer John M. Broder as he drove the Model S from Washington, D.C., to two of Tesla's new charging stations in Newark, Delaware, and Milford, Connecticut, in January 2012. The two stations are approximately 200 miles apart, well within the 300-mile single-charge range of the Model S as stated by Tesla. However, Broder's trip did not go as planned. As the car's battery power fell faster than the miles accrued, Broder was forced to turn off the heat despite the winter day's low temperature, set the cruise at 54 mph on a 65-mph highway, and eventually call a tow truck when the car lost power before reaching the next charging station.[83]

In response to Broder's article, Musk released data logs from the car Broder drove that contradicted his tale, leading to a back and forth that ended in a stalemate. Regardless of the veracity of the article's claims, the negative publicity presented yet another challenge for Tesla. Musk claimed that the negative review potentially cost the company $100 million in lost revenue and stock value and hundreds of cancellations for the Model S.[84]

Elon Musk's smartphone alarm goes off at 6:00 a.m., after a few hours of fitful sleep. Rubbing his eyes, Musk starts to work through the many issues in front of him. He is not only running Tesla Motors on a daily basis, but also has high-level responsibilities at SpaceX and SolarCity. Critics of Musk allege that he is spread too thin and

cannot continue to run three companies at once. Although there is no doubt Musk is a great visionary, engineer, and entrepreneur, is he also a great CEO? His reputation for starting a business and then selling it off (e.g., PayPal sold to eBay) precedes him, but is Tesla the one company at which he will stay to see it succeed?

While sipping his coffee and reviewing the production numbers from the last several weeks, he thinks about his strategic partners, Toyota and Daimler. Providing them with critical components for their electric vehicles is a major milestone for Tesla. Are there other companies that Tesla could partner with to provide similar technology? Should Tesla seek to form partnerships with other major automobile manufacturers? Or should it pursue a deeper alliance with Toyota and Daimler? Will Tesla face the same fate as Fisker?

Tesla's manufacturing record continues to be one of very low volume when compared with that of other major automakers. Will Tesla be able to make the transition to higher production volumes in a relatively short time frame? And can the company fulfill all of the reservations for the Model S on schedule and within budget? Larger automakers have a significant competitive advantage: They have the financial and technological resources to produce automobiles at a much lower cost and get them to the market and customer more quickly. Can Tesla compete with the largest carmakers in the U.S. (GM, Ford, Chrysler, Toyota, and Honda) and disrupt their dominance with an electric vehicle? Musk also worries about Nissan CEO Carlos Ghosn's strong push toward low-cost electric vehicles.

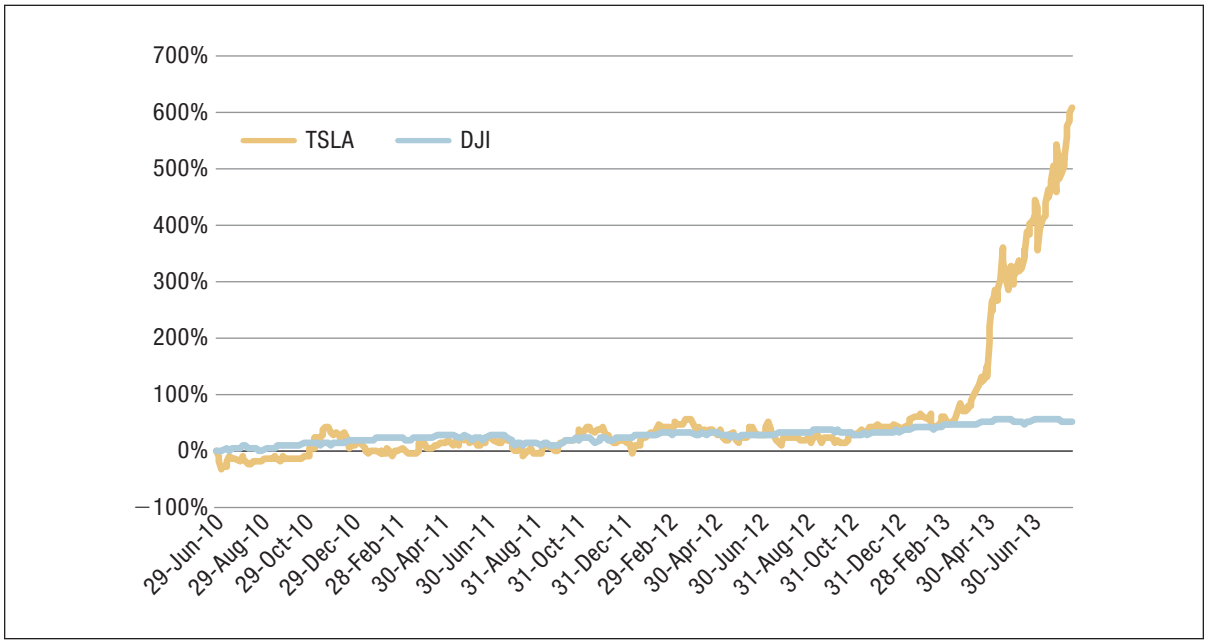
Even though Tesla Motors experienced a profit in the first quarter of 2013, subsequent quarters showed a loss, and critics continue to wonder if Tesla is moving toward profitability. Wall Street has resoundingly confirmed the value of Tesla as the stock price has soared in the last few months. Musk was reassured that electric vehicles, particularly his electric vehicles, stood a chance in the market. It was a long road to reach Tesla's first profitable quarter, and to reach a stock price of $156. Now the challenge is to move lower on the manufacturing learning curve while matching the growing demand at lower cost with the same high quality that distinguish Tesla models from other electric vehicles and rival gas-powered alternatives. As Elon Musk heads out to his first meeting, he wonders what the day's events will bring and if Tesla can manage to succeed in the dynamic automobile market. He is convinced that Tesla will cause sparks to fly.

EXHIBIT 1 Tesla Financial Data (in $ millions, except EPS data)

Fiscal Year	2008	2009	2010	2011	2012
Cash and short-term investments	9.277	69.627	173.155	303.803	220.984
Receivables–total	3.32	3.488	6.71	9.539	26.842
Inventories–total	16.65	23.222	45.182	50.082	268.504
Property, plant, and equipment–total (net)	18.793	23.535	122.599	310.171	562.3
Depreciation, depletion, and amortization (accumulated)	6.826	12.73	22.393	34.222	60.843
Assets–total	51.699	130.424	386.082	713.448	1114.19
Accounts payable–trade	14.184	15.086	28.951	56.141	303.382
Long-term debt	55.416	0.8	72.324	271.165	411.46
Liabilities–total	150.235	64.722	179.034	489.403	989.49
Stockholders' equity–total	–98.536	65.702	207.048	224.045	124.7
Sales (net)	14.742	111.943	116.744	204.242	413.256
Cost of goods sold	11.726	95.468	75.39	125.728	354.364
Selling, general, and administrative expense	77.363	61.432	177.569	313.083	424.35
Income taxes	0.097	0.026	0.173	0.489	0.136
Income before extraordinary items	–82.782	–55.74	–154.328	–254.411	–396.213
Net income (loss)	–82.782	–55.74	–154.328	–254.411	–396.213
Earnings per share (basic) excluding extraordinary items	–0.89	–0.6	–1.66	–2.53	–3.69
Earnings per share (diluted) excluding extraordinary items	–0.89	–0.6	–1.66	–2.53	–3.69

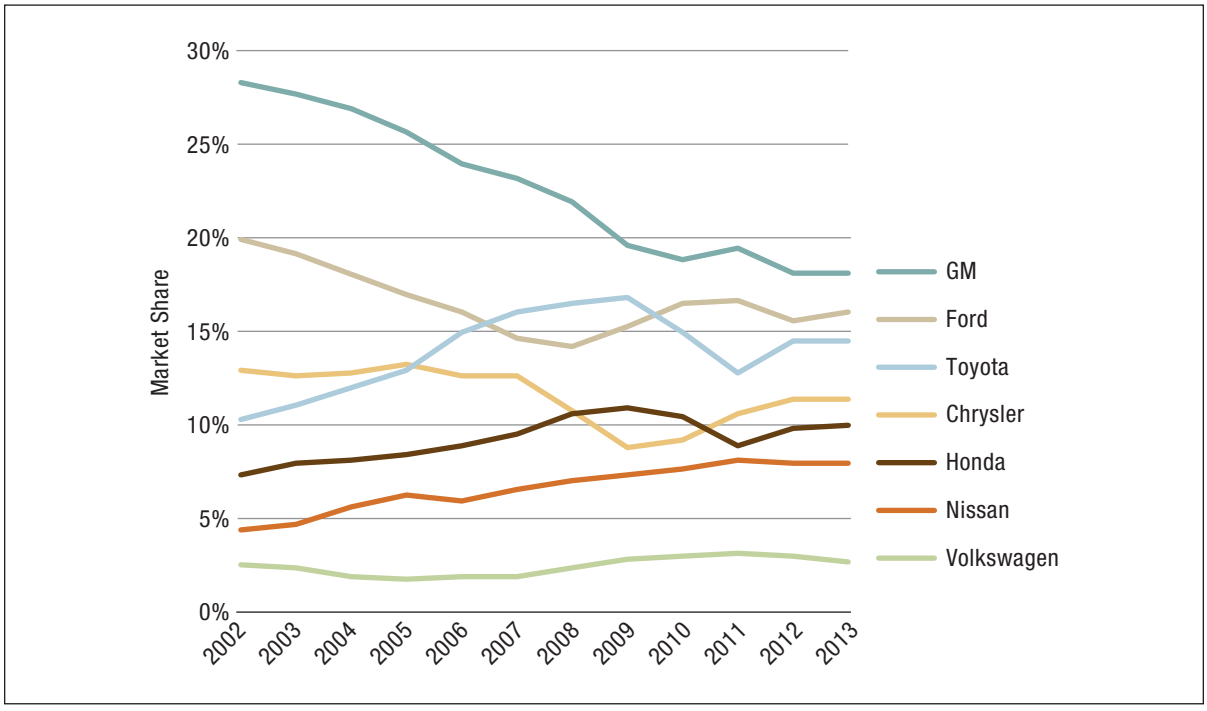
Source: Compustat.

EXHIBIT 2 Tesla Motors' Stock Performance since Its IPO



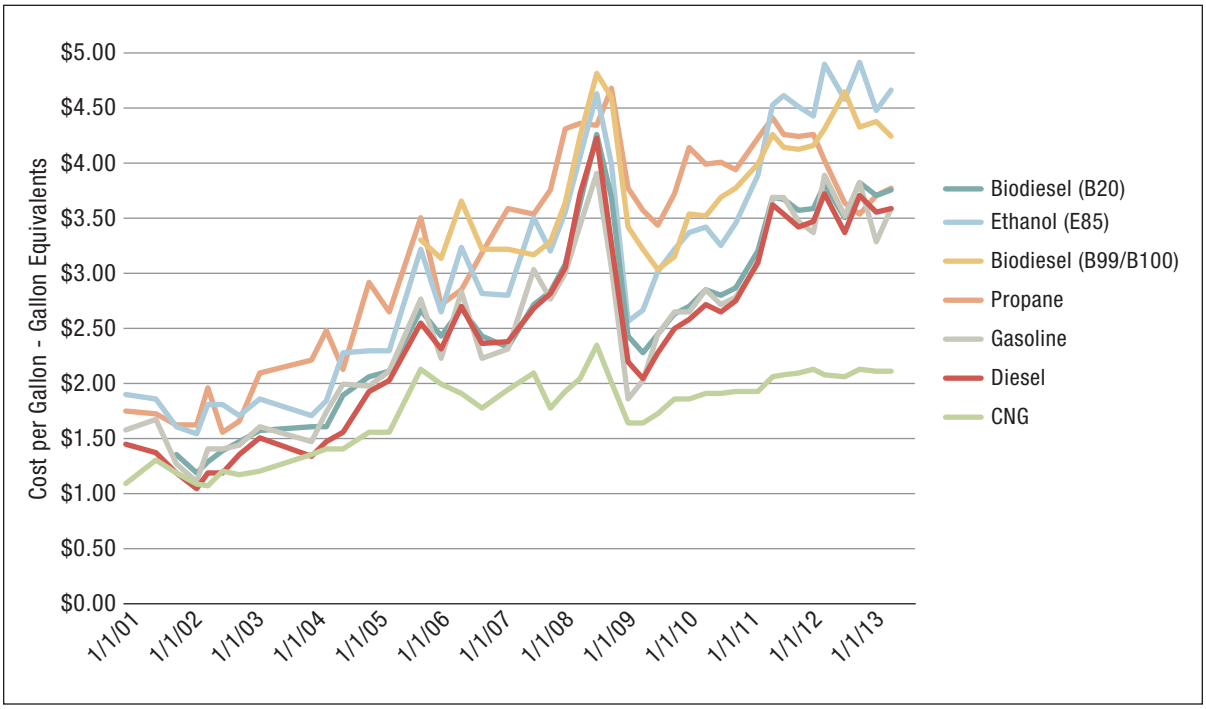
Source: Publicly available data drawn from Yahoo.

EXHIBIT 3 U.S. Market Share: The Big Three vs. "Others," 2002–2013



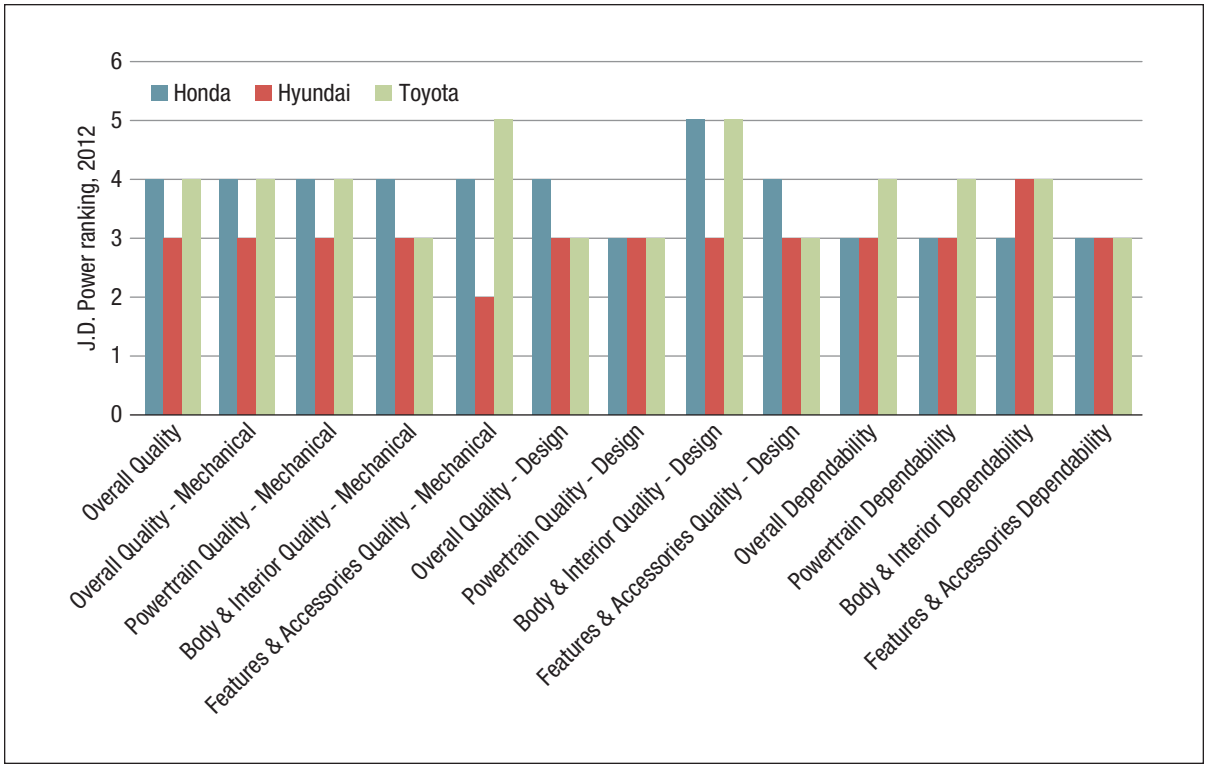
Source: Up to 2010: http://bit.ly/15mHZfo; 2012–2013: http://bit.ly/17Fpk2o; 2011: http://on.wsj.com/1cQWnSq.

EXHIBIT 4 U.S. Average Retail Fuel Prices, 2001–2013



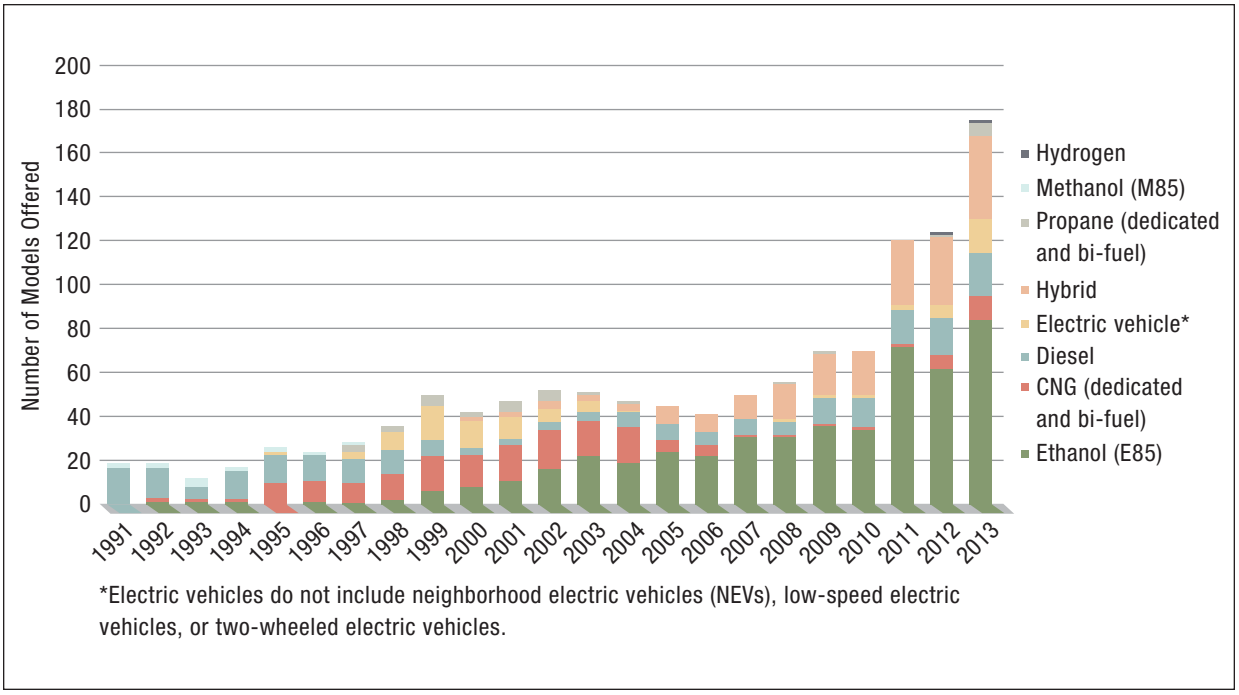
Source: http://1.usa.gov/17eEZVt.

EXHIBIT 5 J.D. Power Quality Rankings, 2012



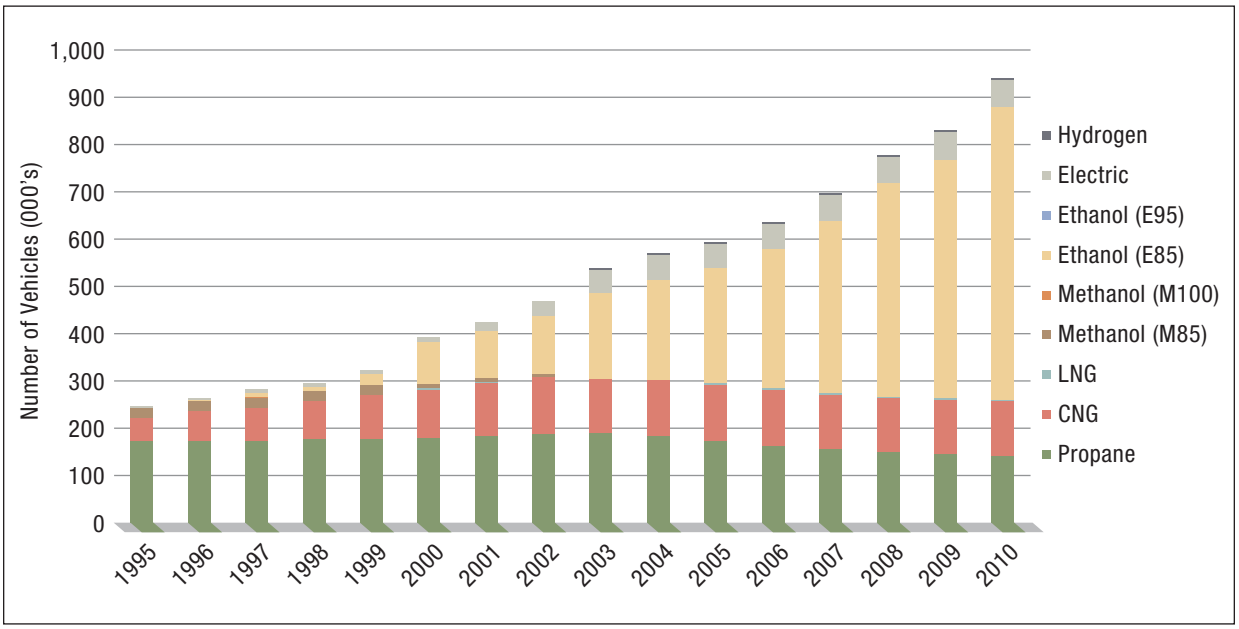
Source: Data adapted from http://bit.ly/14gyiEJ, and http://bit.ly/13XiRyp.

EXHIBIT 6 Alternative Propulsion Vehicle Offerings by Fuel Type, 1991–2013



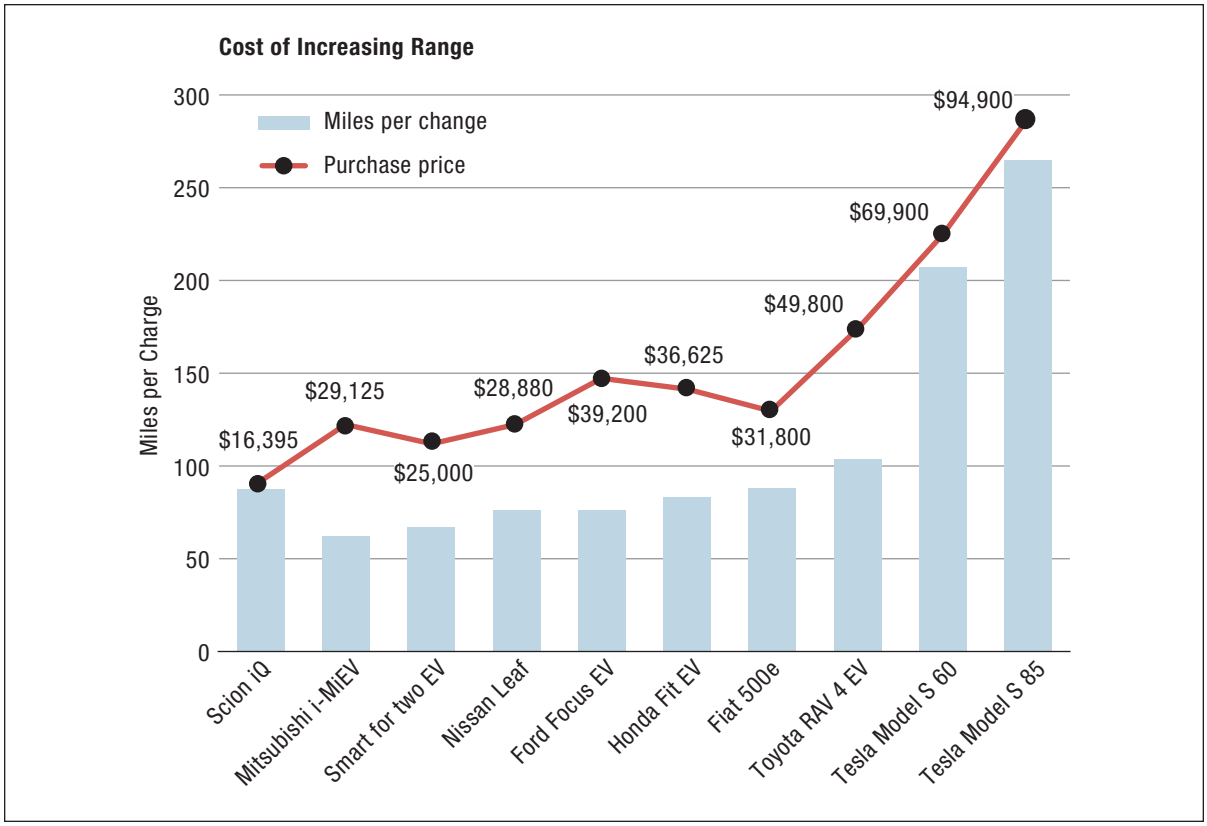
Source: http://1.usa.gov/1cQLHTZ.

EXHIBIT 7 Alternative Fueled Vehicles in Use in the U.S., 1995–2010



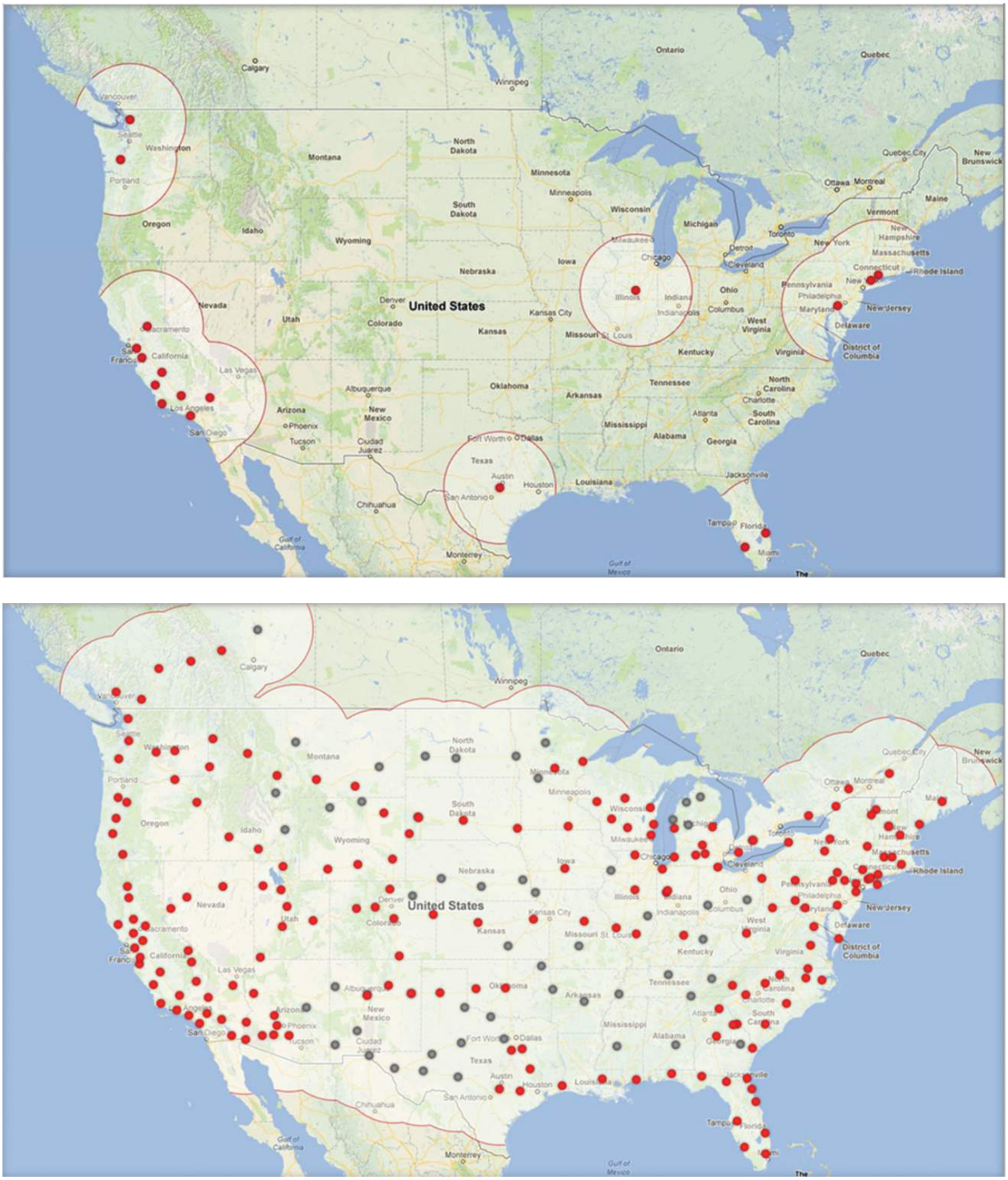
Source: http://1.usa.gov/17X48XA.

EXHIBIT 8 Comparison of Range and Price of BEVs from Various Manufacturers



Source: Authors' adaptation of figure from http://buswk.co/19rt3js.

EXHIBIT 9 Tesla's Expanding U.S. Supercharger Network (top, 2013; bottom, 2015)



Source: http://www.teslamotors.com/supercharger.

EXHIBIT 10 Specifications for Model S Editions

	60 kWh	85 kWh	85 kWh Performance
Est. Range at 55 mph	230 miles	300 miles	300 miles
0 to 60 mph	5.9 seconds	5.4 seconds	4.2 seconds
Quarter Mile Time	14.2 seconds	13.7 seconds	12.6 seconds
Top Speed	120 mph	125 mph	130 mph
Peak Motor Power	302 hp (225 kW) 5,000–8,000 rpm	362 hp (270 kW) 6,000–9,500 rpm	416 hp (310 kW) 5,000–8,600 rpm
Peak Motor Torque	317 lb-ft (430 Nm) 0–5,000 rpm	325 lb-ft (440 Nm) 0–5,800 rpm	443 lb-ft (600 Nm) 0–5,100 rpm
Energy Storage	60 kWh	85 kWh	85 kWh
Battery Warranty	8 years, 125,000 miles	8 years, unlimited miles	8 years, unlimited miles
Supercharging	Optional	Included	Included
Enters Production	In production	In production	In production

Source: www.teslamotors.com.

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