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Government Clean Air Regulations and Tesla Motors

By

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A Thesis Quality Research Paper

Submitted in Partial Fulfillment of the

Requirements for the

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In

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Prof. Frances Edwards. Ph.D.

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INTRODUCTION

National concerns about air pollution, and more recently about climate change, have resulted in the development of policies at the federal and state levels that are designed to improve air quality and lower the emission of greenhouse gasses (GHGs) from human activities like driving. One innovative technology – the all-electric car- has been developed and marketed several times, but only recently has a company become profitable through the sale of only electric cars. Tesla Motors of California has a product line that was developed with both private equity and public loans and grants. What public policy objectives are achieved by the federal and California governments funding Tesla Motors to produce electric cars?

The Energy Independence and Security Act of 2007, (Public Law 110-140), dealt with the energy policy of the United States. The purpose of the law is “to move the United States toward greater energy independence and security, to increase the production of clean renewable fuels, to protect consumers, to increase the efficiency of products, buildings, and vehicles, to promote research on and deploy greenhouse gas capture and storage options, and to improve the energy performance of the Federal Government, and for other purposes.” (Rahall, 2007) This bill did several things: required vehicle technology and transportation electrification; provided incentives for the development of plug-in hybrids; and established a loan program for advancing battery technology. It also awarded grants to automobile manufacturers to promote production of electric transportation technology. (Corporate Average Fuel Economy, 2014)

In 2004, the California State Legislature passed AB 923, a bill which strengthened AB 922, the Carl Moyer Memorial Air Quality Standards Attainment Program (1998), which provides grant funding for cleaner-than-required engines and equipment. Grants are administered by local air districts. The California Air Resources Board (CARB) works collaboratively with the districts and other stakeholders to set guidelines and ensure that the program reduces pollution and provides cleaner air for Californians. The Carl Moyer Program's (1998) goal is to achieve reductions in emissions of key pollutants which are necessary for California to meet its clean air commitments under federal regulatory requirements. AB 923 (2004) expanded the Carl Moyer incentive program to include agricultural sources of air pollution, as well as cars and light-duty trucks. AB 923 (2004) also expanded the program to include hydrocarbon and particulate matter pollution, which supported the purchase of very low or zero-emission vehicles.

In October 2007, Governor Schwarzenegger signed AB 118, which provides approximately \$200 million annually through 2015 for new programs to fund air quality improvement projects and develop and deploy technology and alternative and renewable fuels. Through AB 118 (2007) California has provided ten million dollars in funding to Tesla Motors to create their Model X SUV, an all-electric vehicle that produces no pollution to the environment. California has some of the most stringent state emissions regulations in the U.S. The state allows auto manufacturers who produce a surplus of zero emissions vehicles (ZEV) to sell credits to companies that need to comply with regulations

Tesla Motors was formed in 2003 with the idea of building a car with an alternating current (AC) electric motor. In 2013, Tesla earned its first profit - \$11.25 million in the first quarter. The company also makes money from its competitors in a very crafty way: it sells carbon credits to other automakers. This gives Tesla an economic advantage, since the only product that it sells is emission-free electric vehicles. The company is able to sell credits to companies like General Motors and Ford Motors, among others, who are not currently producing any emission free cars. This has allowed Tesla to make \$2.8 million in 2010, \$2.7 million in 2011 and \$40.5 million in 2012 from its competitors. The number of carbon credits it has to sell is based on the number of all electric cars that it produces within California for that production year. This has been a big contributor to Tesla's ability to show a profit.

Tesla Motors in 2008 had managed to raise over \$140 million dollars in private equity, and had delivered over 500 of its high end roadsters, which retailed for around \$109,000. (Wynn & Lafleur, 2009) Elon Musk, Tesla's CEO, wrote on his blog that the master plan for his company was fairly simple:

- Build sports car
- Use that money to build an affordable car
- Use that money to build an even more affordable car
- While doing above, also provide zero-emission electric-power options (Gertner & Kratochwill, 2012)

Literature Review

The State of California has enjoyed the title “Trailblazer” within the United States as the state that often implements new and creative solutions, most notably to environmental problems. California has often led the way in creating, implementing or improving technology. The State of California can currently boast of having the eighth largest economy in the world, (Yudkin, 2011) demonstrating that environmental leadership does not have to be an economic disadvantage. .

California adopted first-in-the-nation greenhouse-gas (GHG) regulations as part of its groundbreaking, bi-partisan legislation, AB 32 (HSC §38591, 2006) which also included green building codes (HSC§38591) and efficiency standards for automobiles and appliances (HSC §38505) that have rearranged the national energy debate. (Grunwald, 2009)

When it comes to energy, California is not just ahead of the game; it’s playing a different game. Its carbon emissions per capita are less than half the U.S. average. And from 2006 to ’08, it attracted \$3 of every \$5 invested in U.S. clean tech – five times as much as the No. 2 state. It’s by far the national leader in green jobs, green patents, supply from renewables and savings from efficiency. It’s also leading the way toward electric cars, zero-emission homes, advanced biofuels and a smarter grid... (Grunwald, 2009)

In 2002, California passed a law which required vehicle manufacturers to limit emissions of carbon dioxide and other GHGs, starting with the 2009 models. The state needed EPA approval to enforce air pollution standards that were stricter than those of the federal law at that time. The federal agency had granted all such requests by California in the past, but during the Bush Administration the request was rejected. Then

California Governor Arnold Schwarzenegger threatened to sue the US Government for the EPA's intention to not act on California's waiver request, because the EPA was preventing California and the other seventeen states that had adopted California's GHG levels from taking action to reduce GHGs. The seventeen states accounted for about one-third of all US auto sales. Under the Federal Clean Air Act (1963), California had the right to set its own vehicle emission standards, and other states had the right to adopt the California standards as their own, upon receipt of a waiver from U.S. EPA. The Federal agency was obligated to provide California a waiver unless certain conditions were not met. On December 21, 2005, the California Air Resources Board (CARB) requested a waiver of federal preemption of California's GHG standards. The waiver allowed California to enact emissions standards to reduce carbon dioxide and other GHG emissions from automobiles. (Driving the nation - what's driving you?, 2007) On June 30, 2009, the Obama Administration approved California's request for the tougher emission standards. (Zabarenko, 2009)

In 1990 General Motors Corporation unveiled the Impact, a sporty, aerodynamic electric car prototype. In 1998 the California Air Resources Board decided that if a car company could make such a car, it should, and mandated that 2 percent of vehicles sold in the state in 1998 must be emission-free, with that number rising to 10% by 2003.

Since California was and is still one of the largest markets in the United States, Honda, Toyota, Nissan, Chrysler, Ford and GM started building electric vehicles -- about 5,000 were manufactured. But by 2005 the mandate had been eviscerated because of pressure from those same car companies, and 4,000 perfectly good electric vehicles were crushed. (Paul, 2006)

Here are some definitions of types of cars that are being discussed with assistance from Brian Greenstone:

EV - Electric Vehicle: These are pure electric cars with no gas engine at all. They run entirely on battery power, and when the battery dies the car comes to a halt. Examples are the Nissan Leaf and the Tesla Roadster or Model S. (Greenstone, n.d.)



PHEV - Plug-in Hybrid Electric Vehicle: In the strictest sense these are cars that run on both batteries and a gas engine. The gas engine is connected to the drive train and will supply power to the wheels when the battery runs out. The Chevy Volt is such a car. (Greenstone, n.d.)



EV + Range Extender: These are very similar to PHEV's (and are often still referred to as such) in that they have both a gas and electric motor. In this case, however, the gas engine never drives the wheels of the car. The car is a true EV, not a hybrid, but there is a Range Extending gas generator to charge the battery so that the car is not stranded when the battery runs out. The Fisker Karma, now discontinued, was an example of

this, and they called it an EVER - Electric Vehicle Extended Range.

(Greenstone, n.d.)



But did car companies really want electric cars to succeed? The success of electric vehicles would have threatened the status quo and core business models of two of the world's biggest industries -- oil and automobile. Because the small print in California's mandate allowed for car companies to manufacture only as many cars as customers demanded, the compliance strategy was to pretend that there was no demand. Virtually no advertising money was spent to let consumers know that electric cars existed, and salespeople actively dissuaded customers from actually purchasing one. (Paul, 2006)

These cars had great potential, but no media covered their subsequent crushing. It was only with the release of the documentary "Who Killed the Electric Car?" that the full story came out. This film chronicled the rise and fall of the General Motors EV1, an electric car in 1996. Its performance included zero to 60 mph in 7.4 seconds, a top speed of 140 mph and a range of 120 miles. GM discontinued this car just a few years later. (Paul, 2006)

The focus of this research is understanding the public policy objectives that are achieved by the federal and California government funding Tesla Motors to produce electric cars. The answer will be determined through the study of scholarly works on the topic of the role of: cars in GHG emissions in California, the role of electric cars in

lessening the GHG emissions, and the success of electric cars in achieving CARB air quality goals. Some of the literature concludes that California should continue to fund and assist Tesla Motors in developing a totally electric car that is both stylish and economical. (Paul, 2006)

In fact, Tesla's success allowed the Federal Government to continue offering funding for the electric car program. Tesla was awarded \$465 million dollars in U.S. Energy Department loans to develop and build electric cars. (Eisenstein, 2013)The Federal Government is reviving the Advanced Technology Manufacturing, (ATVM) automotive loan program, with \$15 billion still available to encourage the development of electric and other alternative powered vehicles. The program was effectively put on hold two years ago following several problems, and the halt in funding was blamed for the failure of several potentially promising recipients, while critics blamed poor oversight for the loss of money loaned to several other start-ups. (Eisenstein, 2013). The ATVM project came under intense criticism from Republicans, notably including 2012 presidential candidate Mitt Romney, who referred to the companies that had been funded as "losers." (Eisenstein, 2013). Tesla also received \$10 million dollars from California to develop their latest all electric vehicle, the Model X.

In addition to direct funding, Tesla has received millions of dollars from California indirectly through selling California Zero Emission Vehicle Credits to other car companies. "The Zero Emission Vehicle regulation is a requirement that's placed on the large auto makers to make and sell zero emission vehicles," said Ana Lisa Bevan, with the California Air Resources Board. The board requires auto makers to turn in a certain number of credits per year. (Weinberg, 2013). If a company comes up short, it has to

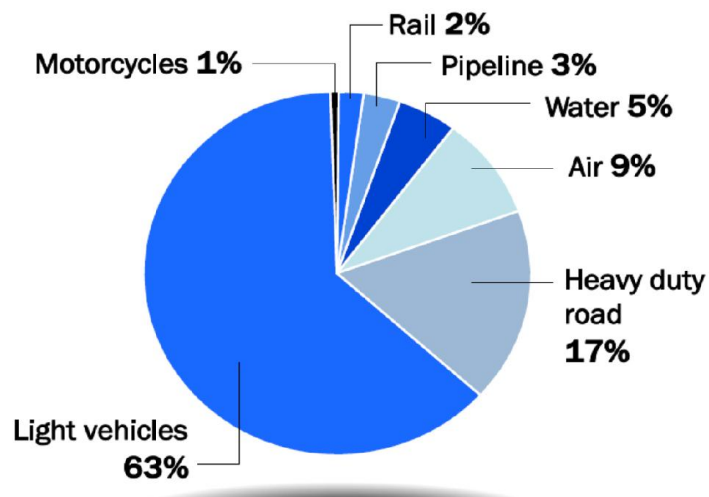
pay a penalty of up to \$5,000 per credit. Alternatively it can buy credits from a company like Tesla, which happened to have earned a lot of credits from manufacturing all electric vehicles. Tesla has sold enough credits to post its first profit.

Other literature states that in a true free market Tesla will either succeed or fail on its own merits and State assistance will only doom or hinder success of the electric car in California. Lubell and Richter state:

Americans driving cars, minivans, sport utility vehicles and pickup trucks burn more than 250,000 gallons a minute, dumping carbon dioxide into the atmosphere at a rate of more than 2,000 metric tons per minute. Doing so, it isn't cheap. It sends more than half a million dollars per minute to the foreign countries that are supplying the oil from which gasoline is made, and many of those countries do not share our values or world view. Transportation accounts for 70 percent of the petroleum we use for fuel, and today we import approximately 65 percent of the petroleum we consume, paying other nations about \$500 billion for the privilege. Transportation's share of the oil bill is about \$350 billion. And in terms of total U.S. fossil fuel usage; transportation represents a 28 percent share. It also represents more than 30 percent of U.S. carbon emissions. (Lubell & Richter, 2011)

Energy and transportation in the U.S.

U.S. transportation energy consumption by mode in 2005.



The United States, including California, has been dependent on foreign oil, which threatens U.S. security and stability, and can leave the U.S. vulnerable. Developing countries, especially India and China, are putting unprecedented demands on world petroleum supplies as they modernize their economies and rapidly increase the size of their vehicle fleets. (Lubell & Richter, 2011)

Alec Brooks and Sven Thesen claim that:

Vehicles that plug into power grid for all of its energy needs have the potential to make valuable contributions to the production, transmission, and distribution of electric power. Plug in vehicles, both battery electric and plug-in hybrids, due to price signals from time of use electrical rates will primarily be charged at night when there is ample generation capacity. By increasing overall electricity infrastructure, fixed-costs will be spread over a wider base, reducing electricity costs to all ratepayers. Plug-in vehicles will also be a new resource to assist with grid operations. Specifically, the energy storage capacity of a plug-in vehicle can be a storage resource for the grid, and vehicle charging rates (quantity and timing) can be controlled remotely by the utilities, aggregator or a grid operator to perform ancillary services for the grid. Further, since the plug-in vehicles' load can be remotely dispatched to provide prompt response to the expected more frequent regulation needs of high levels of intermittent resources, the penetration of intermittent renewable resources such as wind energy have the potential to grow beyond the level that would have been practical without plug-in vehicles. In the future, the current grid model of dispatching generation to match load can be changed for a growing fraction of the total load: load that can be dispatched to match generation. Plug-in vehicles will have this capability and may be a key enabler to a cleaner, more renewable, and lower-carbon grid. (Brooks & Thesen, 2008)

Brooks and Thesen (2008) continue,

“As previously stated, interest in vehicles that can plug into the grid for some or all of their energy needs has been driven by:

- Exhaust emission effects on local air quality
- A desire to diversify energy sources for transportation (with the associated benefit of reducing dependence on foreign oil)
- Global climate change
- Fueling convenience and reduced fuel cost” (Brooks & Thesen, 2008)

Global climate change is another reason to eliminate the use of fossil fuels in California. The State has AB 32, the Global Warming Solutions Act (2006), which reduces CO2 emissions in passenger vehicle fuel content by 2016, and demands a 30% reduction from vehicles sold in California by 2020 to lower the State’s GHG emissions. All electric cars will contribute to the achievement of this goal

This legislation “would ... provide the certainty businesses need to invest in energy efficiency and other projects earlier than required which would speed up greenhouse gas emission reductions,” said Dominic DiMare, vice president of government affairs for the California Chamber of Commerce. (Bruns, 2007)

Bruce McGowan, California’s deputy secretary for economic development and commerce in 2009, said that in the final analysis, that is why most California-based corporate executives choose to do business in the Golden State. “We have more national labs than any other state, and our university system is the model for the U.S.,” he says. “Tesla Motors just got a \$400 – million loan guarantee from the federal government for battery technology.” (Starner, 2009) Tesla Motors has been showing

promise by creating an all-electric sports car that can reach the top speed of 130 mph and go from zero to sixty in four seconds. (Motavalli, 2007) For these reasons and more, manufacturers and the traveling public are increasingly investing in plug-in electric vehicle (PEV) technologies. The Obama administration set a goal of getting 1 million advanced technology vehicles, such as PEVs, on the road by 2015. (Turchetta, 2012)

However, some see these government subsidies as programs that hinder free trade and development of technology that will prosper. As Wynn and Lafleur (2009) write, "Today, many government officials see the electric car as the 'magic bullet' to achieve these goals." The subsidies for electric vehicles and infrastructure are not without economic justification. There are problems with electric vehicles' technology that lead politicians and governments into thinking that the assumed "superior" technology just needs a little help to get off the ground." (Wynn & Lafleur, 2009)

Elon Musk, CEO of Tesla, has met challenge one, and met it with success, so well that in August of 2011, Tesla earned over \$58 million in public trading of the company. (Hull, 2011) Tesla also plans to open factories in Europe and Asia (Ohnsman, 2013a). So the question arises, does Tesla really need government funding to survive? Or will government funding burden the company with unnecessary bureaucracy that will ultimately hinder free trade? For example, in 2010 Tesla Motors was fined \$275,000 by the Environmental Protection Agency (EPA) for Non-Compliance for a car that *cannot produce any emissions*. Tesla's crime? Failing to file for a 2009 emissions "Certificate of Conformity" from the EPA to comply with the "Clean Air Act." until late in the year. (Watts, 2010)

Sometimes following all the required paperwork and rules can hinder creativity and bog down the technology development process. Another example, according to A. Barton Hinkle (2013), is that some people outside of California want to buy Teslas. Unfortunately, states across the country are doing their best to stop them. In Virginia, for instance, you can visit the company's showroom in Tysons Corner to kick the Tesla tires, but until recently that was about all you could do. You could not take a Tesla for a test drive. The company representatives could not even discuss pricing with you and you absolutely, positively could not buy a Tesla then and there.

Those restrictions still exist in most other states: Forty-eight states forbid Tesla to sell cars directly to consumers, which is how the company likes to do business. (Tesla has a variety of reasons for that: Among them, the company charges a single flat price for its cars, but couldn't sustain such a policy if middlemen got involved.) And independent automobile dealers are fighting furiously to keep Tesla out of their backyards. Texas' rules resemble Virginia's. In New York, lawmakers introduced legislation that would have shut down Tesla's three locations by forbidding the registration of any vehicle not purchased through a dealer. In North Carolina, the State Senate passed a bill to forbid vehicle sales except through a franchised dealer. Both of those measures ultimately failed, but until a couple of days ago, when a lawsuit-averting deal was announced, Tesla had not been able to win an exemption from Virginia's rules. Some Virginia dealers wanted to keep it that way. "Tesla believes it should be allowed to sell cars without licensed dealers. This can't be," wrote Gerard Murphy in The Washington Post earlier this year. Murphy is president of the Washington Area New Auto Dealers Association, whose members include dealerships in Northern Virginia. "If Tesla won't have a dealer network, it doesn't belong in the automobile business." (Hinkle, 2013)

This style of hindrance does nothing to improve air quality in the nation. It could frustrate and anger those individuals trying to improve the current situation.

Finally, detractors claim that electric cars pollute just as much because the electricity has to come from somewhere, and it is often from coal-fired power plants. Even if 100% of the electricity came from coal fired power plants it would still result in far less pollution compared with everyone having their own gas powered engines in their cars. The truth is that it is far more efficient to generate large-scale power from a single power station than from 500,000 individual internal combustion engines. Additionally, much of the electricity comes from nuclear, hydro, wind, and solar sources which are clean. Another benefit is that the power plants are often located in remote areas, so cities would be cleaner with electric vehicles. (Greenstone, n.d.)

METHODOLOGY

This research used a process evaluation approach to define the problem that is being addressed, the solution that has been selected, the implementation of that solution, and the outcomes to date, including whether the program is achieving the legislative intent of the Congress and California legislature. Data was collected from government agencies and from Tesla Motors regarding the programs that have led to Tesla becoming profitable while developing a new transportation technology.

Data collection consisted of data gathered from various reports that describe the implementation of the electric vehicle technology solution, including:

- Advanced Technology Vehicles Manufacturing Incentive Program
- Purchase of new very low or zero-emission covered vehicles or covered engines.

- California's attempts to reduce statewide greenhouse gas emissions to 1990 levels by 2020
- California investing in the development of innovative and pioneering technologies that will assist in achieving the 2020 statewide limit on emissions of greenhouse gases
- Research, development, and commercialization of alternative fuels and vehicle technologies that have the potential to strengthen California's economy by attracting and retaining clean technology businesses, stimulating high-quality job growth, and helping to reduce the state's vulnerability to petroleum price volatility.
- Research, development, demonstration, and deployment of alternative and renewable fuels and vehicle technologies will also result in new skill and occupational demands across California industries.

Additional data was gathered to understand the mechanisms that have led to both economic success and emissions reductions. These include

- Tesla paying back the \$451.8 million dollar loan nine years early.
- Tesla using California Zero Emission Vehicle credits to gain profits
- Tesla as part of the carbon tax credit auction system
- Tesla being awarded \$10 million dollars by California to expand its Fremont plant to produce the new Model X SUV.
- California using Tesla's presence in the market to force other car manufacturers to comply with its strict environmental program.

The research then analyzed whether the objectives of the electric car technology are being met:

Finally it analyzed whether the desired outcomes of the solution are being achieved.

- Government, both Federal and California, is doing its best to encourage residents and consumers to conserve energy and reduce GHG emissions.
- Public is less concerned about GHG emissions and more concerned about individual cost, comfort and convenience.
- Clean Energy practices will not truly become effective until the public becomes more concerned about the environment and is involved in conserving energy and reducing emissions.

Meanwhile, Teslas are selling well enough in the luxury car market to make a profit for the investors, contributing to a reduction in GHG and enabling the sale of more desirable standard cars through the carbon tax credit market.

FINDINGS

Increasing corporate average fuel economy standards

The U.S. Environmental Protection Agency (EPA) and the Department of Transportation's National Highway Traffic Safety Administration (NHTSA) issued final rules extending the National Program to further reduce greenhouse gas (GHG) emissions and improve fuel economy for model years (MYs) 2017 through 2025 light-duty vehicles. EPA established national GHG emissions standards under the Clean Air

Act, and NHTSA has established Corporate Average Fuel Economy (CAFE) standards under the Energy Policy and Conservation Act, as amended by the Energy Independence and Security Act (EISA). These regulations were first enacted by the U.S. Congress in 1975 in the wake of the Arab Oil Embargo, and were intended to improve the average fuel economy of cars and light trucks (trucks, vans and sport utility vehicles) sold in the United States. If the average fuel economy of a manufacturer's annual fleet of vehicle production falls below the defined standard, the manufacturer must pay a penalty, currently \$5.50 USD per 0.1 mpg under the standard, multiplied by the manufacturer's total production for the U.S. domestic market. In addition, a Gas Guzzler Tax is levied on individual passenger car models (but not trucks, vans, minivans, or SUVs) that get less than 22.5 miles per US gallon.

EPA's standards apply to passenger cars, light-duty trucks, and medium-duty passenger vehicles, in MYs 2017 through 2025. The final standards are projected to result in an average industry fleet wide level of 54.5 miles per gallon (mpg) if achieved exclusively through fuel economy improvements. Light-duty vehicles are currently responsible for nearly 60 percent of U.S. transportation-related petroleum use and GHG emissions.

This national program conserves billions of barrels of oil, cuts carbon pollution, protects consumer choice, and enables long-term planning for automakers. (United States Environmental Protection Agency, 2012)

Starting in 2011 the CAFE standards are expressed as mathematical functions depending on vehicle "footprint", a measure of vehicle size determined by multiplying the vehicle's wheelbase by its average track width. A complicated 2011 mathematical

formula was replaced starting in 2012 with a simpler inverse-linear formula with cut-off values. CAFE footprint requirements are set up such that a vehicle with a larger footprint has a lower fuel economy requirement than a vehicle with a smaller footprint. For example, the 2013 Honda Fit with a footprint of 40 square feet must achieve fuel economy (as measured for CAFE) of 31 miles per US gallon, equivalent to a published fuel economy of 27 miles per US gallon, while a Ford F-150 with its footprint of 65–75 square feet must achieve CAFE fuel economy of 22 miles per US gallon, i.e., 17 miles per US gallon published. CAFE 2016 target fuel economy of 38.5 MPG compares to 2013 actual advanced vehicle performance of Tesla Model S: 95 MPGe and LEAF electric vehicle: 115 MPGe. (United States Department of Energy, 2014)CAFE has separate standards for "passenger cars" and "light trucks", despite the majority of "light trucks" actually being used as passenger cars. More recently, coverage of medium duty trucks has been added to the CAFE regulations starting in 2012, and heavy duty commercial trucks starting in 2014.

The National Highway Traffic Safety Administration (NHTSA) regulates CAFE standards and the U.S. Environmental Protection Agency (EPA) measures vehicle fuel efficiency. U.S. Congress specifies that CAFE standards must be set at the "maximum feasible level". In comparing gas powered vehicles to the electric ones, the values are exceeded by nearly triple. These electric vehicles that out produce gas powered vehicles in mileage also create no greenhouse gases, achieving the federal government's mandates and objectives.

Improving vehicle technology

Plug-in electric vehicle (EV) technology is an option with the potential to displace a significant portion of transportation-related petroleum consumption by using electricity for all of a given trip. Plug-in electric vehicles use an electric motor powered by an energy storage system and only use electricity from the utility grid. A key benefit of plug-in electric is that the vehicle is no longer dependent on a single fuel source. The primary energy carrier would be electricity generated using a diverse mix of domestic resources including coal, natural gas, wind, hydro, and solar energy. (Brooker, Thornton, & Rugh, 2010)

Energy storage remains a key barrier to the viability of electric vehicles. EV technology is not without its own technical challenges. Energy storage system (ESS) cost, volume, and life are the major obstacles that must be overcome for these vehicles to succeed. Nonetheless, these technologies provide a relatively near-term possibility for achieving petroleum displacement. One of the key factors in assessing the potential fuel use reductions of EVs is to assess its fuel use relative to specific configurations and component sizes (energy storage trade-offs) and how it competes with both conventional vehicles and other advanced technology vehicles, such as HEVs, in terms of cost, performance, and petroleum displacement potential. By doing this relative comparison, cost-effective pathways to vehicle sector electrification can be identified. (Brooker, Thornton, & Rugh, 2010) The long term potential for battery technology to meet performance and cost targets for battery electric vehicles has important implications for fuel cell vehicles. Tesla has been working to improve this issue in three

separate directions: the first is implement a quick replacement swap of its battery system in ninety seconds, less time than it takes to fill a standard gas power vehicle.

The second direction is Tesla developing rapid charging stations that will recharge their vehicle's battery with a 50% charge within 20 minutes and a full charge taking 75 minutes. To achieve this goal, Tesla has also been building their own charging networks in the US, Canada, and Europe. Owners of a Tesla electric car can now travel from San Diego to Vancouver, British Columbia and the major hubs in between using only Tesla's own "supercharger" stations. The company said in a press release that 99% of Californians and 87% of owners in Washington and Oregon are now within 200 miles of a station. (Dorrier, 2014) Tesla has also installed these "Supercharging" stations all across the US. In an effort to highlight this, Tesla has sponsored and published articles about owners travelling across the nation in their S model Tesla vehicles. The owners all state that initially they had concerns about finding charging stations, but were never stranded in their journey across the nation.

The third way that Tesla has been working to improve vehicle technology is to further improve the electric vehicle's battery technology. This evaluation of future battery technology is shifting to the lithium-ion battery technology. The lithium-ion has shown higher performance, potential for lower cost production and most importantly higher capability for long term storage to power the vehicles. It has become the key driver for Tesla in the development of automotive energy storage systems. In fact, Tesla plans to break ground this year and the company hopes its factory, named the "Gigafactory", will produce lithium-ion batteries for 500,000 vehicles by 2020. That output would be equivalent to the total number of lithium batteries produced worldwide last year.

(Johnson, 2014) Besides increasing vehicle supply, the facility could allow Tesla to experiment with other battery sizes and formats. In fact, Tesla has been in discussions with Apple. While there was speculation that Apple was interested in purchasing the automotive company, others are considering that the discussions were about production of lighter, more effective and longer lasting batteries for their phones. The plant is also planning to use green energy, and indicated that it will be powered at least in part by wind and solar energy. (Johnson, 2014)

Tesla's new factory is meant to overcome the challenges that face modern battery technology. These challenges are primarily exemplified in cost and efficiency. A typical lithium-ion battery for one of Tesla's vehicles costs the automaker approximately \$50,000. The costs of battery technology is passed down to the consumer, who must pay more to purchase an electric vehicle. Improved production of a better operating battery, and being able to produce it at a significantly lower cost. would also lower the purchase price of the vehicle and increase the vehicle's mileage output.

Reduce nitrogen oxides for light vehicle sources in the state

In 2011, nitrous oxide (N₂O) accounted for about 5% of all U.S. greenhouse gas emissions from human activities. Nitrous oxide is naturally present in the atmosphere as part of the Earth's nitrogen cycle, and has a variety of natural sources. However, human activities such as agriculture, fossil fuel combustion, wastewater management, and industrial processes are increasing the amount of N₂O in the atmosphere. Nitrous oxide molecules stay in the atmosphere for an average of 120 years before being removed by

a sink or destroyed through chemical reactions. The impact of 1 pound of N_2O on warming the atmosphere is over 300 times that of 1 pound of carbon dioxide.

Nitrous oxide is emitted when transportation fuels are burned. Motor vehicles, including passenger cars and trucks, are the primary source of N_2O emissions from transportation. The amount of N_2O emitted from transportation depends on the type of fuel and vehicle technology, maintenance, and operating practices. Nitrous oxide is a byproduct of fuel combustion, so reducing mobile fuel consumption in motor vehicles can reduce transportation emissions. (EPA, 2014)

Tesla is an all-electric vehicle and therefore does not produce any emissions, although some argue that power plant emissions must be considered. When this has been done previously, the numbers have still favored electric cars. The Union of Concerned Scientists, for example, concluded in a 2012 report, "Electric vehicles charged on the power grid have lower global warming emissions than the average gasoline-based vehicle sold today." (Noland, 2014) It could also be implied that emissions from the various power plants that generate electricity could increase N_2O contributions if a plant were generating electricity from coal instead of solar or water.

Provide incentives for the early retirement of fuel inefficient passenger vehicles

In an attempt to boost sagging U.S. auto sales and to promote higher vehicle fuel economy, President Obama signed legislation on June 24, 2009, PL 111-32, establishing a program to provide rebates to prospective purchasers toward the purchase of new, fuel-efficient vehicles, provided the old trade-in vehicles were

scrapped. The program was known as Consumer Assistance to Recycle and Save (CARS), or, informally, as “cash for clunkers.” It provided rebates of \$3,500 or \$4,500, depending on fuel economy and vehicle type of both the new vehicle and the vehicle to be disposed of. Congress appropriated \$3 billion for the program in two separate installments (Yacobucci & Canis, 2010) When NHTSA regulations were issued, the CARS program was embraced by thousands of consumers and by auto dealers across the country, who advertised it widely. By the end of the first week, the U.S. Department of Transportation (DOT) announced that nearly all of the initial \$1 billion in funds appropriated for it were committed, based on rising dealer applications for rebate reimbursements and surveys of dealer backlogs.

Recognizing the stimulative effect of the program, the House of Representatives voted to appropriate an additional \$2 billion (HR 3435) on July 31, 2009, tapping funds from the economic recovery act (American Recovery and Reinvestment Act, or ARRA, PL 111-5). The Senate followed suit on August 6, 2009, and President Obama signed the supplemental CARS funding into law (PL 111-47) on August 7, 2009. (Yacobucci & Canis, 2010) Similar programs have been implemented in various U.S. states, but this was the first federal program. In general those state pilot programs focused on retiring vehicles with older, and in some cases malfunctioning, emissions control systems in order to promote better air quality. CARS focused, instead, on higher fuel economy and promoting U.S. auto sales.

In its report to Congress, NHTSA estimates that the CARS program will save roughly 820 million gallons of fuel and 9.5 million metric tons of carbon dioxide over the next 25 years. These savings are relatively small compared to projected fuel

consumption and transportation emissions. For example, compared to the Energy Information Administration's (EIA) estimates for motor gasoline consumption and carbon dioxide emissions from petroleum consumption in 2020 in the transportation sector, the estimated annual savings from the CARS program represent roughly 0.02% of both consumption and emissions.

The CARS program has been criticized by environmentalists because its scope was too small to affect significant change in the auto sector, and the required increases in fuel economy were not stringent enough. (American Council for an Energy-Efficient Economy, 2009) This too was the case for Tesla, but for a much different reason. Tesla's vehicles are clearly unique and game changers, but far too expensive to become a mainstream item for the common consumer, and therefore not the best use for a trade-in value for most consumers. A price tag of \$70,000-\$100,000, effectively excludes the majority of the population from owning a Model S.

Also, Tesla's mode of selling their cars does not allow for the trade-in of older vehicles. This sales model has been generating difficulties for Tesla in several states, like New Jersey. As of April 1, 2014 New Jersey said it is illegal to operate factory-direct car sales in the state. Arizona, Maryland, Texas and Virginia also ban direct sale of cars to consumers. (O'Dell, 2014) "Tesla -- as innovative, different and disruptive as it may be -- is still a small player in a very large arena. It sold just under 25,000 cars last year globally. General Motors sold more than that every day. If Tesla has an eye on significant growth, the traditional dealership model, in its most progressive form, is a path the brand shouldn't ignore." (O'Dell, 2014)

Tesla sells directly to the consumer and does not take trade in vehicles, something that could really help eliminate older and less effective gas using vehicles from the road. Founder Elon Musk told company shareholders last year that some states' laws requiring Tesla to sell through independent dealers constituted nothing less than a "perversion of democracy." He recently blogged that established dealers "have a fundamental conflict of interest between promoting gasoline cars, which constitute virtually all of their revenue, and electric cars, which constitute virtually none." (Farnham, 2014) "So far, Tesla's game plan is to make its money purely on car sales. (Electric cars bring in almost no service and maintenance income, which is lifeblood to most car dealers.) There also is no bargaining at Tesla, where the manufacturer's suggested retail price is the sales price, take it or leave it." (O'Dell, 2014) With the introduction of the lower priced Model X and the increase in vehicle size with a SUV model, this can change and create trade-in capability for Tesla. Also with a much larger market available with a lower priced vehicle, Tesla may have to adopt another method of sales of their vehicles to reach a larger population of consumers.

Data Collection

Advanced Technology Vehicle (ATV) Manufacturing Incentives

The ATVM loan program was established in 2007 by the Energy Independence and Security Act (EISA) to provide up to \$25 billion in loans for projects to produce more fuel-efficient passenger vehicles and their components. The fiscal year 2009 continuing resolution provided the ATVM loan program with \$7.5 billion in appropriations to cover credit subsidy costs. DOE has made five loans worth \$8.4 billion and used \$3.3 billion in appropriations to cover credit subsidy costs. Loans awarded were:

- Ford Motor Company, *\$5.907 billion*, Sep 2009: to upgrade factories across Illinois, Kentucky, Michigan, Missouri, and Ohio and to introduce new technologies to raise the fuel efficiency of more than a dozen popular vehicles. **Results:** 4,000 jobs created, 2,380,000 tons of CO₂ avoided annually, and the removal of 509,000 polluting and non-efficient cars annually off the road through trade-ins. (US Department of Energy, 2013)
- Nissan North America, *\$1.448 billion*, January 2010: to retool its Smyrna, Tennessee assembly plant to manufacture all-electric automobiles in addition to existing Nissan vehicles, and to construct an advanced battery manufacturing facility. **Results:** 1,300 jobs created, 51,000 tons of CO₂ avoided annually, and the removal of 11,000 polluting and non-efficient cars annually off the road through trade-ins. (US Department of Energy, 2014)
- Tesla Motors, *\$465 million*, January 2010 to: (1) reopen an auto manufacturing plant in Fremont, California to produce EVs, and (2) develop a manufacturing facility to produce battery packs, electric motors and other powertrain components that will power all-electric plug-in vehicles manufactured by Tesla and other original equipment manufacturers, including Daimler and Toyota. **Results:** *Loan Completely Repaid*, 1,500 Jobs Created, 52,000 tons of CO₂ avoided annually, and the removal of 11,000 polluting and non-efficient cars annually off the road, based on the replacement of some other vehicle with a Tesla. (US Department of Energy, 2013)

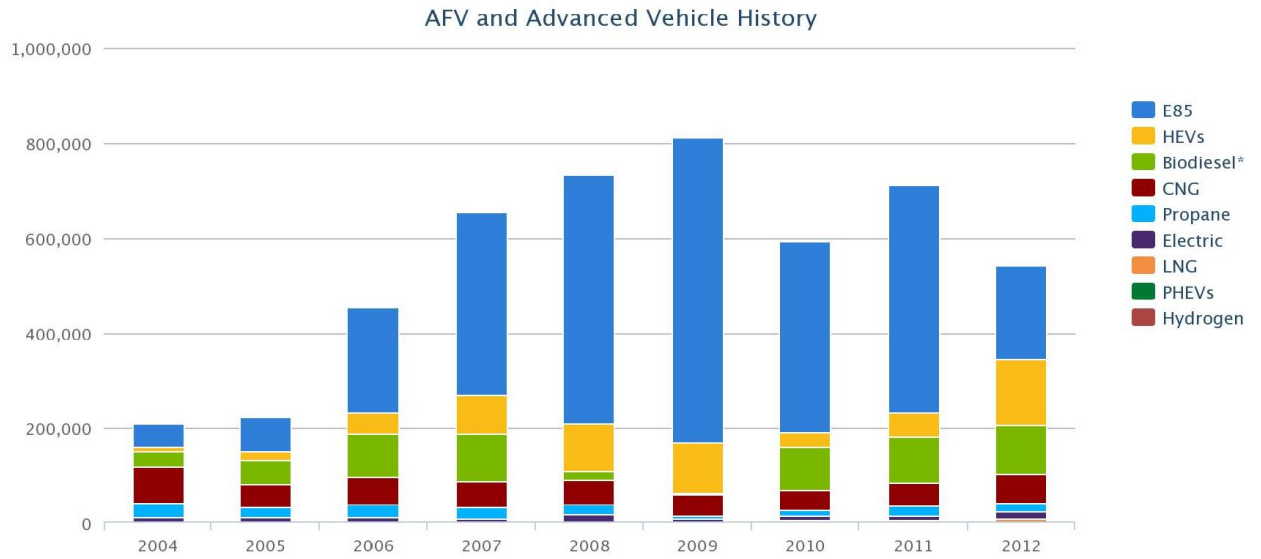
- Fisker Automotive, \$529 million, April 2010: for the development and production of two lines of plug-in hybrid electric vehicles. **Results:** *Defaulted and closed* (US Department of Energy, 2013)
- The Vehicle Production Group, \$50 million, March 2011: to support the development of the six-passenger MV-1, a factory-built wheelchair accessible vehicle that will run on compressed natural gas. **Results:** 900 jobs created, 12,200 tons of CO₂ avoided annually, and the removal of 3,000 polluting and non-efficient cars annually off the road. *Defaulted and closed this past May.* (US Department of Energy, 2013)

It had been reported that in 2013 senior officials from the Department of Energy had signaled that the Obama administration was ready to restart the program. A total of \$15 billion, or 60 percent of the original \$25 billion set aside, is still available, and there is no official end date the administration has to meet. (Eisenstein, 2013) As of early 2014, the program has not been revived and no new programs have been awarded.

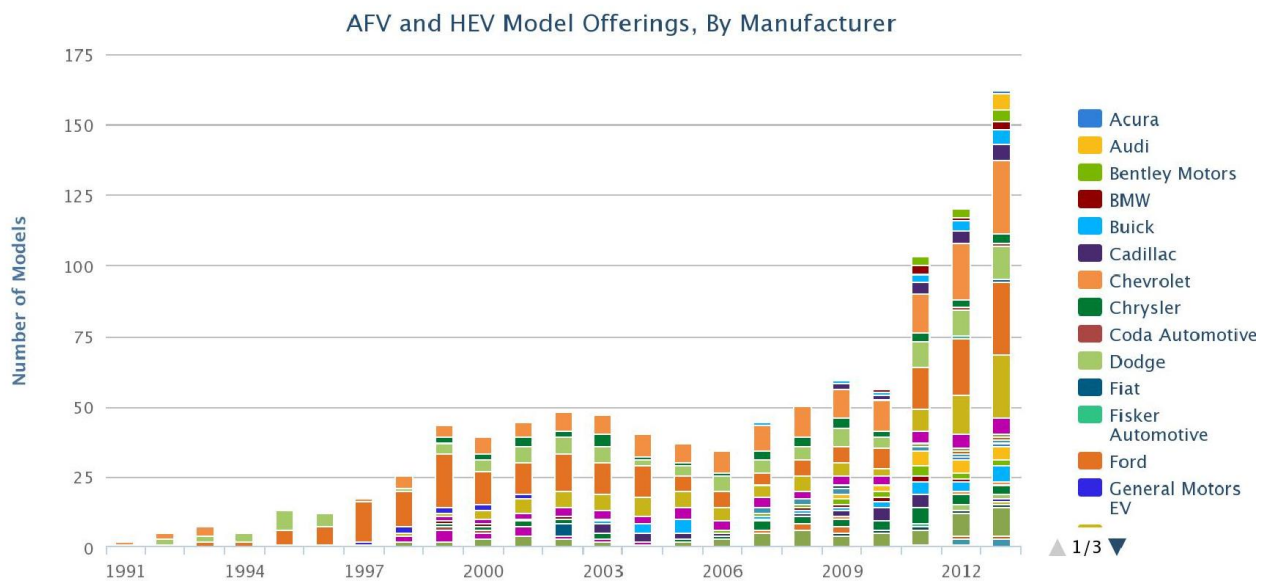
Purchase of Zero-Emission Vehicles

There are no official number on the sales of electric vehicles, although it is estimated that Tesla sold at least 22,450 last year, based on figures previously released (Ohnsman, 2014). The following charts show the increased growth of electric vehicles, especially from 2011 to 2012, when the growth nearly doubled. Also included is a chart that illustrates the numbers of electric vehicles that are offered on the market for purchase. As the charts illustrate, the market has grown. As the market has offered more electric vehicles, the corresponding following year, the purchase of the vehicles has grown. In fact, there is speculation that Tesla Motors could become true competition for other automakers, particularly if and when Tesla's "Gen 3" car goes on sale sometime in 2016 or 2017. That model, widely but unofficially called the Model E, will be a mass-market car aimed at the Audi A4, BMW 3 Series, and Mercedes-Benz C-Class. With an expected sticker price of around \$40,000 and a range of about 200 miles, the E could attract mainstream consumers, along with individuals who currently own electric vehicles. (Lavrinc, 2014)

Clean Air and Tesla Motors 30



(US Department of Energy, 2014)



(US Department of Energy, 2014)

California's attempts to reduce statewide greenhouse gas emissions to 1990 levels by 2020

Senate Bill (SB) 375, adopted in 2008, calls on regional transportation planning agencies and local governments to develop strategies for reducing greenhouse gas emissions from passenger vehicles by reducing per capita vehicle miles traveled (VMT). Senate Bill 375 is expected to reduce emissions only moderately compared to vehicle efficiency standards and low carbon fuels. Greenhouse gas emissions in California have been increasing steadily over the past several decades, with the fastest growth occurring in the transportation sector. The transportation sector is the largest single contributor to GHG emissions in the state, accounting for 37 percent of all emissions. Passenger cars and trucks account for almost three-quarters of this total. (Bedsworth, Hanak, & Kolko, 2014) Senate Bill 375 is expected to achieve only modest benefits, accounting for 8% of all GHG emission reductions in the transportation sector by 2020, and approximately 3% of all emission reductions economy wide. (Bedsworth, Hanak, & Kolko, 2014) In addition, Senate Bill 375 has survived legal challenges and remained intact. In its June 19, 2012 decision in *Association of Irrigated Residents v. California Air Resources Board*, the court rejected claims by environmental groups that the Plan violated the Global Warming Solutions Act of 2006. The case presented a number of claims under AB 32, including that the Plan (1) did not go far enough in seeking to reduce GHG emissions, (2) failed to use a standard measure to evaluate cost-effectiveness, (3) failed to include mandatory measures for the agricultural sector, and (4) did not adequately evaluate public health impacts. According to the court, while opinions may differ on the complex issues involved in attempting to reduce California's

GHG emissions, the Air Board's findings and recommendations reflected the exercise of sound judgment, supported by substantial evidence and in conformance with AB 32.

(Bruner, 2012)

California investing in the development of innovative and pioneering technologies that assist in achieving the 2020 statewide limit on emissions of greenhouse gases.

In 2011, the California Air Resources Board adopted the nation's first state-administered cap-and-trade regulations, a landmark set of air pollution controls to address climate change and help the state achieve its ambitious goals to reduce greenhouse gas emissions. Cap and trade is a market-based approach used to control pollution by providing economic incentives for achieving reductions in the emissions of pollutants.

A governmental body, in this case the California Air Resources Board, sets a limit or cap on the amount of a pollutant that may be emitted. The limit or cap is allocated or sold to firms in the form of emissions permits, which represent the right to emit or discharge a specific volume of the specified pollutant. The program started January 1, 2012 with an enforceable compliance obligation beginning with the 2013 GHG emissions. (California Environmental Protection Agency Air Resources Board, 2014)

Firms are required to hold a number of permits (or allowances or *carbon credits*) equivalent to their emissions. The total number of permits cannot exceed the cap, limiting total emissions to that level. Firms that need to increase their volume of emissions must buy permits from those who require fewer permits. (Cart, 2011)

The transfer of permits is referred to as a trade. In effect, the buyer is paying a charge for polluting, while the seller is being rewarded for having reduced emissions. Thus, in theory, those who can reduce emissions most cheaply will do so, achieving the pollution reduction at the lowest cost to society. (Cart, 2011)

Emissions caps were established by collecting three years of emissions data from the state's largest industries. Businesses were grouped into sectors and assigned an average emissions benchmark. They are allowed to emit up to 90% of that amount in the first year. Companies that operate efficiently under the cap may sell their excess carbon allowance on the market; companies whose emissions are above the benchmark must either reduce their carbon output or purchase credits or offsets. (Cart, 2011) Offsets are a way of turning carbon "savings" into tradable equities. For instance, a forestry company may change its practices so that its forests store more carbon. That increase in carbon storage can be turned into a marketable credit. An independent entity verifies that the carbon savings are real. That additional storage must be maintained for at least 100 years. No carbon offsets may be purchased from non-U.S. sources. (Cart, 2011) The California Air Resources Board operates the market and hires an auction host and monitors. By 2016, about \$10 billion in carbon allowances are expected to be traded through the California market, which will be the second-largest carbon market in the world behind the European Union. (Cart, 2011)

Research, development and commercialization of alternative fuels and vehicle technologies that have the potential to strengthen California's economy by attracting and retaining clean technology business, stimulating high-quality job growth, and helping to reduce the state's vulnerability to petroleum price volatility.

To provide consumers and businesses an option in the fuels or vehicles they use besides the main gas products, new markets must be created and existing markets grown. Creating and developing lucrative and profitable alternative and renewable fuels industries are the most significant incentives, besides improving the environment. Production of alternative and renewable fuels and vehicle technologies in California have the potential to strengthen the economy by attracting and retaining clean technology businesses, stimulating high - quality job growth, and helping to reduce the state's vulnerability to petroleum price volatility. Research, development, and deployment of alternative and renewable fuels and vehicle technologies will also result in new skill and occupational demands in California industries.

Investing in the development of innovative technologies advances California's leadership in clean technologies, achieves oil reduction objectives, improves air quality and meets GHG emission reduction objectives, develops public/private partnerships, and ensures a secure and reliable fuel supply that does not solely depend on oil.

A Center for the New Energy Economy report entitled *Powering Forward: Presidential and Executive Agency Actions to Drive Clean Energy in America (2014)*

states that actions could be taken by the federal government to move towards a clean energy future that curbs climate change:

- A Clean Energy Grand Challenge – EV Everywhere program designed to make electric vehicles as affordable and convenient as gasoline powered vehicles for the average American family by 2022. (Center for the New Energy Economy, 2014)
- Requirements that all federal government fleet purchases must be alternative fuel vehicles by 2015 and that federal agencies must cut their petroleum consumption by 30%. (Center for the New Energy Economy, 2014)
- The first-ever efficiency and greenhouse gas emission standards for heavy-duty vehicles starting in 2014 (Center for the New Energy Economy, 2014)

Research development, demonstration, and deployment of alternative and renewable fuels and vehicle technologies will also result in new skills and occupational demands across California industries

Many “green” jobs in today’s economy owe their existence to federal policy initiatives in four key areas: environmental policy, energy policy, green government initiatives, and labor policy. Several executive and legislative bodies are active in policy development related to the green economy. They include the Environmental Protection Agency; the Department of Energy; the Department of Labor; the Department of Agriculture; the U.S. Senate Committee on Environment & Public Works - Subcommittee on Green Jobs and the New Economy; and the U.S. House of Representatives Energy and Commerce Committee – Subcommittee on Energy and

Environment. (Peters, Eathington, & Swenson, 2010) The potential growth of green jobs is an important selling point for green policies.

Green jobs growth projections have an important workforce development component. Not all emerging green jobs will require newly trained individuals. Some jobs will fundamentally be similar to earlier characterizations but will require either an enhancement in skills or in knowledge. (Peters, Eathington, & Swenson, 2010) Many experts also predict that these “new” positions will be in fact enhanced or replacement positions for those who are currently employed in oil refining/gas technology fields that will become obsolete as green technologies take over. No matter how it is defined, the fact is that “green” positions are coming and there is a definite need to increase the education and recruitment for these positions as businesses and the government try to reshape and reduce their dependence on oil.

How Does Tesla Impact The Data?

In many ways, Tesla gleefully plays the role of spoiler. This is a company that thrives in an arena where experts have continuously stated that nothing could be done to interest consumers in investing in electric vehicle transportation, or purchasing electric vehicles. Tesla has thrived in situations where their competition has gone bankrupt. Tesla has supported both the federal government's and the State of California's environmental standards that other businesses, especially the major vehicle producers, said could not be done without a major loss of profit to the business. Tesla has proven the nay-sayers wrong and done it while growing stronger and gaining economically.

In 2013, Tesla paid off a \$465 million loan that the Energy Department made in 2010. The repayment was a lift to the Obama administration, whose clean-energy loan programs faced criticism after the collapse of Solyndra, the solar panel maker. The repayment of the loan early also shows the potential for growth within the electric car field, demonstrating that there is a ready and available market and consumers for electric vehicles. The company repaid the government nine years before its loan was due, a move characterized as “push[ing] the Big Three automakers down the energy efficiency track.” (Eavis, 2013)

Tesla's 2013 fourth quarter sales included a net income of \$46 million without selling any Zero Emissions Vehicle credits, (George, 2014) demonstrating their ability to compete in the car market. This contradicts critics who contend that Tesla is only profitable because it sells ZEV credits. There are currently 24 models of electric cars for sale in the United States, from the Wheego Whip selling at \$18,995 to the BMW i8 selling at \$135,700. (Clean Technica, 2014) The numbers and models of electric vehicles in the US market are increasing every year, demonstrating that. The electric vehicle market is a growing alternative to gas powered vehicles.

The State of California Zero Emission Vehicle (ZEV) standard requires that a certain percentage of an auto maker's California sales must be zero-tailpipe-emission vehicles. For 2014 this requirement is about 1% of sales, and the percentage is expected to increase to 16% in 2015. If a manufacturer does not meet this standard, it must buy zero-emission-vehicle credits from a manufacturer that has a surplus of credits. Tesla only produces electric vehicles and therefore has a surplus of credits. General Motors was a major buyer of those Tesla surplus credits in 2013, purchasing

over 300 zero-emission credits and over 500 "partial" credits. In fact, Tesla stands to profit in 2015 as the California law gets tougher. Chris Isidore writes, "If they fall short of those sales goals, they can avoid penalties -- and bad publicity -- by buying credits from other automakers. Since Tesla sells nothing but electric cars, it is rolling in the credits and is one of the few sellers." (Isidore, 2013) . These numbers will continue to increase as the zero-emission mandate becomes more stringent. "They're in a position to potentially corner the market," said Adam Jonas, auto analyst with Morgan Stanley, who estimated that the credits will come to \$188 million in 2013. (Isidore, 2013) Tesla transferred 1,311.52 ZEV credits from Oct. 1, 2012, through Sept. 30 2013, 3 times the number sold by Suzuki Motor Corp. (7269), the next biggest seller, according to a California Air Resources Board. (Ohnsman, 2013b)

California is using Tesla's presence in the market to convince the major car manufacturers to comply with, and the market is benefitting by the presence of zero emission vehicles. The car manufacturers have had a long history of opposing tougher environmental regulations in California. The state's chief air quality regulator said zero-emission vehicles were crucial to meeting looming federal deadlines and denied favoring any particular automotive technology. (Hirsch, 2013) "We are in the air pollution business, not the car business," said Mary Nichols, chairwoman of the Air Resources Board, which has broad control over environmental policy in California. "There is some jealousy of Tesla going on here." (Hirsch, 2013) "If we want to prevent the worst effects of climate change, we need an 80% reduction in greenhouse gases by the 2050 time frame," said Don Anair, research director for the clean vehicles program at the Union of

Concerned Scientists. To achieve that, car companies need to get started now to perfect technology for zero-emission vehicles, he said. (Hirsch, 2013)

The car manufacturers are complying with the regulations, but their lobbying arm, the Alliance of Automobile Manufacturers, are petitioning the EPA to block California's ambitious requirement. "The ZEV mandate is a field of dreams mandate — if you build it they will come," said Gloria Bergquist, spokeswoman for the alliance. "There is a requirement that we build these vehicles and put them on dealers' lots, but there is no requirement that consumers buy them." (Hirsch, 2013) As of December 2013, the United States has the largest fleet of plug-in electric vehicles in the world, with over 170,000 highway-capable plug-in electric cars sold since the market launch of the Tesla Roadster in 2008. (Shepardson, 2014) U.S. sales of plug-in electric and hybrid vehicles almost doubled between 2012 and 2013 with an 84 percent jump to 96,600 of the vehicles sold, that's 49,000 plug-in hybrids and 47,600 pure battery powered plug-in vehicles sold. (Justian, 2014) The market has been supporting the California mandate and the reduction of carbon emissions.

In fact, Tesla has been expanding its Fremont, California manufacturing plant to produce its new Model X SUV, partially funded by a \$10 million dollar grant by the State of California. The Tesla Model X is not due, at the earliest, until the end of 2014, but preorders are apparently creating a long waitlist for consumers waiting to purchase an electric vehicle. While there has been no official statement from Tesla, sources are estimating that pre-orders are around 9,900 for the new Model X orders from the US (around 1,350 of them the Signature Series). (Blanco, 2014) To reserve a Signature series Model X, the early-production fully-loaded series, customers are required to put

down \$40,000 with their reservation, rather than the standard \$5,000 deposit. (DeMorro, 2014) These numbers do not include the orders from China which are expected to be substantial. Overall Tesla is growing stronger in a market where the major competition may have to reclassify this competitor from niche market player to upstart competitor that could challenge the major car manufacturers in the near future for an increasing market share of vehicle profits.

Analysis

Tesla is now starting to thrive in a market where many critics had predicted that it would fail. Elon Musk, owner of Tesla, admitted in an interview on the CBS Television Show, "Sixty Minutes", that he thought that his company was going to fail. American made examples like Fiskar and Phoenix Motorcars who have entered the market using an all-electric vehicle model have gone bankrupt quickly. Tesla has endured and now is starting to thrive, creating waitlists from consumers and industry accolades, such as Motor Trend Car of the Year for 2013. Consumer Reports called the Tesla Model S the best car it has ever tested. The Model S earned a score of 99 out of a possible 100 in the magazine's tests. (Valdes-Dapena, 2013)

Independent testing by the National Highway Traffic Safety Administration (NHTSA) has awarded the Tesla Model S a 5-star safety rating, not just overall, but in every subcategory without exception. Approximately one percent of all cars tested by the federal government achieve 5 stars across the board. NHTSA does not publish a

star rating above 5, however safety levels better than 5 stars are captured in the overall Vehicle Safety Score (VSS) provided to manufacturers, where the Model S achieved a new combined record of 5.4 stars. (Tesla Motors, 2013)

Tesla has filled a needed niche for United States Department of Energy and the State of California where regulations called for all electric vehicles to be built and where the major car companies repeatedly stated that it could not be economically done. Tesla has created an environmentally friendly and stylish vehicle that is popular not just in America but worldwide.

As Tesla starts to flourish, it is dispelling the myth that electric vehicles were not desired by the public. California Legislators created the ZEV mandate in 1990. "The mandate consisted of just a few sentences, stating that major manufacturers' California sales must include at least a 2% ZEV in the model years 1998 through 2000, 5% in 2001 and 2002 and 10% in 2003 and subsequent years." (Fairley, 2007) The program was challenged by a GM led lawsuit. The litigants stated that the California Air Resources Board (CARB) was in fact regulating fuel efficiency, a power granted the federal government. CARB settled the suit by giving automakers a way out, by allowing the car manufacturers to create fuel-cell vehicles. By 2003 the Big 6, DaimlerChrysler, Ford, GM, Honda, Nissan and Toyota, had recalled and crushed (in Honda's case shredded) all of the 4400 electric vehicles created in California's first ZEV program after the settlement. (Fairley, 2007) California regulations for cleaner gas vehicles and the production of all electric vehicles has been consistently resisted by the auto industry. Daniel Sperling, director of the University of California, Davis Institute of Transportation Studies, has said, "Companies are going just to pick the easy way and the easy way is

not necessarily in the public's interest." (Fairley, 2007) However, the success of Tesla's electric vehicles has validated the interest and support from both the Federal government and the State of California, whose investment of tax dollars to support Tesla Motors has returned multiple benefits, including a repaid loan, eliminating many of the critics' claims that electric vehicles are not desired by the public. The waitlists, interest and controversy over how Tesla vehicles are sold has indicated that there is a great attentiveness to electric vehicles, not just in California but across the nation..

In fact, the interest in electric cars is a surprise; considering the high price tag, lack of charging stations and performance of electric cars. Tesla has started to change the criticisms of electric vehicles. The Model S has changed many people's idea of all electric cars with the unexpected style and performance. Tesla plans to continue to change the public's views as they increase locations where their cars can be charged, shorten the length of time it takes to recharge and the distance that is traveled between charges, and most importantly, the cost to purchase an electric vehicle. Tesla's Model X with its gullwing door system is expected to sell at a price lower than the Model S currently selling for \$63,570.00. Tesla is also planning to produce a Model E, within the next three to four years, that is expected to challenge the major car manufacturers with a selling price at around \$40,000. Tesla currently has an 8.4% market share, which means is that Tesla is outselling models like the Audi A8 (base MSRP: \$72,200), BMW 7 Series (\$73,600) and Mercedes S-Class (\$92,350). (King, 2013)

Conclusion

Tesla's 42% market share in the United States electric car market (Peerce-Landers, 2013) has produced a 13% reduction in GHG production for every electric vehicle purchased. (Tesla Motors, 2014) Depending on other factors, such as how the electricity is being generated, renewables versus coal, the GHG production could be reduced even further.

Tesla sales appear to be coming at the expense of BMW, Mercedes, Lexus and Porsche. As Tesla continues to open new sales and service locations across the country while simultaneously growing its network of high-speed Supercharger stations, the major car manufacturers are starting to take notice and fight back. They are creating their own versions of all electric vehicles, such as the Fiat 500e, the BMW i3 and the Mercedes all electric B Class. However these vehicles are lacking in the size and luxury expected of these famed name brand vehicles. Tesla is also facing opposition to their sales approach, selling directly to the consumer, from the powerful independent car retailer association lobby. These are indicators that Tesla has grown into a creditable challenger and competitor to the major car manufacturers.

Government, both federal and the State of California, is doing its best to encourage consumers to conserve energy and reduce greenhouse gas emissions. The United States is likely to reduce its greenhouse gas emissions by 16.3% from 2005 levels by 2020, falling just shy of the 17% target pledged by President Obama at the 2009 climate talks in Copenhagen, Denmark, according to a new study. Dallas Burtraw, and co-author Matt Woerman calculate that the largest portion of projected emissions

reductions will come about through U.S. EPA regulations of mobile sources, such as cars and light trucks, and stationary sources, such as power plants and industrial facilities. (Eshelman, 2012) As for the State of California, it has experienced record clean tech venture capital investment and green jobs, which are growing at ten times the rate of jobs in other sectors of the economy since AB 32 passed. (Environmental Defense Fund, 2014)

The federal Government and the State of California are reducing GHG emissions and preserving clean air through various implemented government programs. Clean Energy practices will not truly become effective until the public becomes more involved. Currently, the public is less concerned about greenhouse gas emissions and more concerned about individual comfort and convenience. One way Tesla is making change occur is through continued education of the general public. The American public has some knowledge about Greenhouse Gas Emissions, but the true effect is not yet directing their consumer choices. Most Americans are seeking comfort, style and an image that attracts them. Tesla has found a method to reach the American consumer by providing a vehicle that is stylish and also is totally electric. The total electric component is an additional selling point, but not the main drawing issue. Until the American public becomes totally invested in reducing GHG, concrete action for environmental improvement will not be achieved.

SOURCES CONSULTED

Alliance, A., & Alliance, B. (2011). Clean energy manufacturing in California.

American Council for an Energy-Efficient Economy. (2009). **Vehicle scrappage**

program needs repair. Retrieved May 3, 2014, Retrieved from

<http://www.aceee.org/press/2009/05/vehicle-scrappage-program-needs-repair>

Bedsworth, L., & Hank, E. (2011). *Driving change: Reducing vehicle miles traveled in California* Public Policy Instit. of CA.

Blanco, S. (2014). Does Tesla really have 12,000 Model X preorders? Retrieved May 3, 2014,

Brooker, A., Thornton, M., & Rugh, J. (2010). Technology improvement pathways to cost-effective vehicle electrification: Preprint.

Brooks, A., & Thesen, S. H. (2007). PG&E and Tesla Motors: Vehicle to grid demonstration and evaluation program. *Evs23*,

Bruner, M. (2012). **California court of appeal upholds statewide climate change scoping plan**. (California Land Use & Development Law Report). San Francisco: Perkins Coie LLP. (AB-32, California Air Resources Board, Cap-and-Trade, CARB, GHG, Global Warming, Global Warming Solutions Act, Greenhouse Gas Emissions)

- Bruns, A. (2007). **Millions of reasons from customers to colleges to clean technology, California makes the connections.** Retrieved May 1, 2014, Retrieved from <http://www.siteselection.com/features/2007/mar/california/>
- California Environmental Protection Agency Air Resources Board. (2014, March 28, 2014). Cap-and-trade program. Retrieved from <http://www.arb.ca.gov/cc/capandtrade/capandtrade.htm>
- Cart, J. (2011). California becomes first state to adopt cap-and-trade program. *Los Angeles Times*. October, 21, 2011.
- Center for the New Energy Economy. (2014). *Powering forward: presidential and executive agency actions to drive clean energy in America*. (). Fort Collins, CO: Center for the New Energy Economy.
- Choi, D. G., Kreikebaum, F., Thomas, V. M., & Divan, D. (2013). Coordinated EV adoption: Double-digit reductions in emissions and fuel use for \$40/vehicle-year. *Environmental Science & Technology*, 47(18), 10703-10707.
- Choi, D. G., Kreikebaum, F., Thomas, V. M., & Divan, D. (2013). Coordinated EV adoption: Double-digit reductions in emissions and fuel use for \$40/vehicle-year. *Environmental Science & Technology*, 47(18), 10703-10707.
- Clean Technica. (2014). **Electric cars for sale in 2014.** Retrieved May 3, 2014, Retrieved from <http://cleantechnica.com/car-answers/>
- Cobb, J. (2014). Top 6 plug-in vehicle adopting countries. *Hybrid Cars*, May 5, 2014.

Congress, U. S. (2007). Energy independence and security act of 2007. *Public Law, 2*

Corporate Average Fuel Economy. (2014, April 22). In *Wikipedia, The Free*

Encyclopedia. Retrieved 08:18, May 6, 2014,

from [http://en.wikipedia.org/w/index.php?title=Corporate Average Fuel Economy&oldid=605302721](http://en.wikipedia.org/w/index.php?title=Corporate_Average_Fuel_Economy&oldid=605302721)

Cross-state air pollution rule (CSAPR). (2014). *United States Environmental Protection Agency,*

de Haan, P., Peters, A., & Scholz, R. W. (2007). Reducing energy consumption in road transport through hybrid vehicles: Investigation of rebound effects, and possible effects of tax rebates. *Journal of Cleaner Production, 15*(11), 1076-1084.

Deal, W. F. (2010). Going green with electric vehicles. *Technology and Engineering Teacher, 70*(3), 5-11.

DeMorro, C. (2014). **Tesla Model X reservations exceed 12,000.** *Gas 2*, May 3, 2014.

Dorrier, J. (2013). **Tesla's rapidly expanding network of charging stations form unbroken chain up the west coast.** *Singularity HUB*, May 1, 2014.

Eathington, L., Swenson, D. A., & Peters, D. J. (2011). *An Exploration of Green Job Policies, Theoretical Underpinnings, Measurement Approaches, and Job Growth Expectations,*

Eavis, P. (2013). **In a plus for electrics, Tesla repays a big federal loan early.** *New York Times*, May 5, 2014.

Edelstein, S. (2014). **Even small towns see demand for electric-car charging.**

Retrieved May 1, 2014, Retrieved from

http://www.greencarreports.com/news/1091006_even-small-towns-see-demand-for-electric-car-charging

Eisenstein, P. A. (2013). **Officials: Obama to revive controversial auto loan program.** *CNBC, Autos*, May 3, 2014.

Eisler, M. N. (2009). Getting power to the people: Technological dramaturgy and the quest for the electrochemical engine. *History and Technology*, 25(1), 49-68.

Environmental Defense Fund. (2014). **California's global warming solutions act.**

Retrieved 5/3/2014, 2014, Retrieved from <http://www.edf.org/climate/AB32>

Eshelman, R. S. (2012). **U.S. may come close to 2020 greenhouse gas emission target.** *Scientific American*,

Fairley, P. (2007). California to rule on fate of EVs [news]. *Spectrum, IEEE*, 44(11), 10-12.

Fairley, P. (2011). Will electric vehicles finally succeed? *Technology Review*, 114(1), 58-63.

- Farnham, A. (2014). **Will Tesla forfeit its direct sales model?**. Retrieved May 3, 2014, Retrieved from <http://abcnews.go.com/Business/tesla-forfeit-direct-sales-model/story?id=22957480>
- Fell, J. (2008). How to get 100mpg from your car. *Engineering & Technology*, 3(2), 44-47.
- George, P. (2014). **Tesla's ZEV credit win should silence some of their critics.** *Jalopnik.Com*, 5/3/2014.
- Gertner, J., & Kratochwill, L. The risk of a new machine. *Fast Company*, (164), 104-111.
- Goodwin, K. J. (2010). Reconstructing automobility: The making and breaking of modern transportation. *Global Environmental Politics*, 10(4), 60-78.
- Gov. Schwarzenegger tells U.S. EPA of inevitable lawsuit on greenhouse gas waiver. (June 13, 2007). *Driving the Nation - what's Driving You?*, May 3, 2014.
- Greenstone, B. Facts about electric cars. Retrieved May 3, 2014, Retrieved from <http://www.briangreenstone.com/electric-cars/index.html>
- Grunwald, M. (2009). The end of California: Dream on. *Time Magazine*, 174(17), 26-34.
- Hidrue, M. K., Parsons, G. R., Kempton, W., & Gardner, M. P. (2011). Willingness to pay for electric vehicles and their attributes. *Resource and Energy Economics*, 33(3), 686-705.

Hinkle, A. B. (2013, September 30, 2013). **Tesla Motors and the folly of government intervention.** *Reason*,

Hirsch, J. (2013, 5/5/2013). **Tesla drives California environmental credits to the bank.** *Los Angeles Times*

Horn, M. (2010). Roadmap to the electric car economy-there's no time like the present to replace all our gas-powered automobiles with electrics, says an aerospace scientist. *Futurist*, 44(2), 40.

Hull, D. (2011, August 4, 2011). Best quarter in Tesla's history. *San Jose Mercury News*, pp. D1-D4.

Isidore, C. (2013). **How Tesla's rivals support Tesla.** Retrieved May 3, 2014, Retrieved from <http://money.cnn.com/2013/05/21/news/companies/tesla-windfall/>

Johnson, T. (2014). **Tesla's alternative energy future aims for massive lithium-ion battery production.** *SF Gate*, May 3, 2014.

Justian, E. (2014). **US plug-in electric vehicle sales nearly double in 2013.** *Triple Pundit*, May 3, 2014.

King, D. (2013). **Tesla's 8.4% market share beats Audi A8, BMW 7 series.** *Autobloggreen*,

Lane, B. W., Messer-Betts, N., Hartmann, D., Carley, S., & Graham, J. D. (2012).

Government promotion of the electric car: Risk management or industrial policy?

European Journal of Risk Regulation, 227-- 245.

Lane, B. W., Messer-Betts, N., Hartmann, D., Carley, S., Krause, R. M., & Graham, J.

D. Government promotion of the electric car: Risk management or industrial policy?

European Journal of Risk Regulation, 4(2), 227-245.

Lavrinc, D. (2014). **Tesla keeps poaching Prius buyers, and It's not slowing down.**

Wired, May 4, 2014.

Lubell, M. S., & Richter, B. (2011). Energy efficiency: Transportation and buildings.

Paper presented at the *Physics of Sustainable Energy II: Using Energy Efficiently and Producing it Renewably*, 1401(1) 107-152.

MacPherson, N. D., Keoleian, G. A., & Kelly, J. C. (2012). Fuel economy and

greenhouse gas emissions labeling for Plug-In hybrid vehicles from a life cycle perspective. *Journal of Industrial Ecology*, 16(5), 761-773.

Malaczynski, J. D., & Duane, T. P. Reducing greenhouse gas emissions from vehicle

miles traveled: Integrating the California environmental quality act with the

California global warming ... *Ecology Law Quarterly*, 36(1), 71-135.

Michaels, P. J. (2013). If Tesla would stop selling cars, we'd all save some money.

Minsk, R. E., Ori, S. P., & Howell, S. Plugging cars into the grid: Why the government

should make a choice. *Energy Law Journal*, 30(2), 317-376.

- Motavalli, J. (2007). Here come the cleaner, greener cars. *E Magazine Mar*, 27.
- Mourad, M. (2011). Improving the performance of a hybrid electric vehicle by utilization regenerative braking energy of vehicle. *International Journal of Energy & Environment*, 2(1), 161.
- Noland, D. (2013). **Does the Tesla model S electric car pollute more than an SUV?**. *Popular Science*, May 4, 2014.
- Nunez, F. (2006). Assembly bill 32: The California global warming solutions act of 2006.
- O'Dell, J. (2014). **Why Tesla should stop fighting auto dealers**. *CNN Opinion*, May 4, 2013.
- Ohnsman, A. (2013, August 22, 2013). **Tesla eyes Asia, Europe to build mass-market electric car**. *San Jose Mercury News*, pp. B8.
- Ohnsman, A. (2013). Tesla tops California green-car credit sales in past year. *Bloomberg.Com*, May 5, 2014.
- Ohnsman, A. (2014). Tesla rises after model S sales in 2013 exceed forecast. *Bloomberg*, May 5, 2013.
- Overview of greenhouse gases**. (2014). *United States Environmental Protection Agency*, May 3, 2014.
- Paul, A. (2006). Who killed my electric car? *CNN.Com*, May 5, 2014.

- Pearre, N. S., Kempton, W., Guensler, R. L., & Elango, V. V. (2011). Electric vehicles: How much range is required for a day's driving? *Transportation Research Part C: Emerging Technologies*, 19(6), 1171-1184.
- Peerce-Landers, P. (2013). **7 things to know about electric vehicles**. *Motley Fool*, p366.
- Perl, A., & Dunn Jr, J. A. (2007). Reframing automobile fuel economy policy in North America: The politics of punctuating a policy equilibrium. *Transport Reviews*, 27(1), 1-35.
- Phillips, A., McGee, R. & Kristinsson, J. (2013). **Smart, connected and the future of the automobile**. Retrieved 5/1, 2014, Retrieved from <http://www.realtimerecommunicationsworld.com/news/2013/03/15/6994941.htm>
- Salisa, A. R., Zhang, N., & Zhu, J. (2011). A comparative analysis of fuel economy and emissions between a conventional HEV and the UTS PHEV. *Vehicular Technology, IEEE Transactions on*, 60(1), 44-54.
- Sedgwick, S. M. (2012). In Cooper C. (Ed.), *Electric vehicles: The market and its future workforce needs*. Los Angeles, CA: Los Angeles County Economic Development Corporation.
- Sharke, P. (2004). Freedom of choice (electric vehicles). *Mechanical Engineering*, 126(10), 1-9.

Skinner, J. (2011). Who killed the hybrid car-state and local green incentive programs after metropolitan taxicab board of trade v. city of New York in the second circuit. *Stan.Envtl.LJ*, 30, 311.

Starnner, R. (2009). The price of success for California companies, the cost of doing business is a trade-off. Retrieved May 1, 2014, Retrieved from <http://www.siteselection.com/features/2009/sep/California/>

Tesla Motors. (2013). **Tesla Model S achieves best safety rating of any car ever tested**. Palo Alto, CA: Tesla Motors.

Turchetta, D. (2012). The car of the future, today. *Public Roads*, 76(3)

United States Environmental Protection Agency. (2014). **All-electric vehicles: Compare side-by-side**. Retrieved May 5, 2014, Retrieved from <http://www.fueleconomy.gov/feg/evsbs.shtml>

US Department of Energy. (2014). US Department of Energy loans program office. Retrieved May 5, 2014, Retrieved from <http://energy.gov/lpo/projects>

US Department of Energy, Energy Efficiency & Renewable Energy. (2013). **Alternative fuels data center**. Retrieved May 5, 2014, Retrieved from <http://www.afdc.energy.gov/data/>

Valdes-Dapena, P. (2014). **Tesla: Consumer Reports' best car ever tested**. *CNN: Money*, May 5, 2014.

van Wee, B., Maat, K., & De Bont, C. (2012). Improving sustainability in urban areas: Discussing the potential for transforming conventional car-based travel into electric mobility. *European Planning Studies*, 20(1), 95-110.

Vanzetto, P. (2014). *My dream of the eternal car is a reality*. Palo Alto, CA: Tesla Motors.

Voelcker, J. (2007). TOP 10 TECH CARS 2007-pure-electric cars are back--and they include a US (USD) 130 000 speedster. *IEEE Spectrum*, 44(4), 30.

Voelcker, J. (2009). How green is my plug-in? *Spectrum, IEEE*, 46(3), 42-58.

Voelcker, J. (2006). Electric cars for enlightened stars. *Spectrum, IEEE*, 43(11), 14-16.
doi:10.1109/SPEC.2006.247950

Watts, A. (2010). **EPA fines Tesla Electric Motors \$275,000 for non-compliance.**
Watts Up with that?, May 5, 2014.

Weinberg, D. (2013). **Tesla's secret to success? Selling emissions credits.**
Marketplace Sustainability, May 5, 2014.

Wirasingha, S. G., & Emadi, A. (2011). Classification and review of control strategies for plug-in hybrid electric vehicles. *Vehicular Technology, IEEE Transactions on*, 60(1), 111-122.

Wynn, T., & Lafleur, S. (2009). A free market perspective on electric vehicles. *Portland, OR: Cascade Policy Institute*,

Yacobucci, B. D., & Canis, B. (2009). Accelerated vehicle retirement for fuel economy: "cash for clunkers". Paper presented at the

Zabarenko, D. (2009). **EPA approves California auto emissions standard**. Retrieved May 5, 2014, Retrieved from <http://www.reuters.com/article/2009/06/30/us-autos-epa-california-idUSTRE55T4PR20090630>

Zhang, M., Yang, Y., & Mi, C. C. (2012). Analytical approach for the power management of blended-mode plug-in hybrid electric vehicles. *Vehicular Technology, IEEE Transactions on*, 61(4), 1554-1566.