Electric Cars and Utility Pricing

By: Garrett Gottfried

Introduction:

In 1769 Frenchman Nicholas Cugnot built the first steam powered motor carriage, this was a self-propelled vehicle large enough for one person and cargo. This motor carriage would eventually start the revolution of transportation that would lead to the automobiles that we use today. Since the steam engine was created there have been many technological advances to cars including the gas motor and the electric vehicle. Robert Anderson of Aberdeen, Scotland built the first electric car in 1839. This carriage used a non-rechargeable battery and was not a very effective means of travel causing very little impact in the history of automobiles. Extraordinary advances in the electrical cars have been made over the past 200 years. All of these travel advances have been towards efficiency of energy, cleaner emissions and economically profitable ways to travel in our everyday lives. Electrical charging vehicles must have efficient pricing of electricity by utilities to make a difference in the long run. The main economic issue that this project will address is, "will electric vehicles in the long run be economically profitable, efficient and beneficial?"

The research and development of transportation to becoming efficient and sustainable has been a very long and on-going process. This transformation of cars started in the early 1800's about 40 years after Cugnot created the first steam powered motor carriage. These first sets of cars used internal combustion engines that were developed for running on fuel gas which lead to the modern gasoline engine that cars use today. During this time when the fuel gas engine was being used Robert Andersons invention of the first crude battery powered carriage that was overlooked, this did not last for very long though. In the early 1900's electric vehicles gained popularity outselling gas vehicles, President Woodrow Wilson and Thomas Edison were famous people that backed the idea of electric vehicles. These vehicles at the time could travel anywhere from 55 to 70 miles per charge, which is almost the standard for electric vehicles today.

Electric vehicles were used in the early 1900's, the technology in these cars were seen and used in trolley systems around cities. National City Lines, Inc. a front company for General Motors, Firestone Tire, Standard Oil of California and Phillips Petroleum acquired these local transit systems shutting down trolleys and replacing with gasoline powered buses. This went on bringing up cases of conspiring to monopolize with sales of buses and other problems by National City Lines, which ended up in conviction. Around this time there was a halt in production towards electric vehicles that did not see interest again until the late 1990's. Popularity rose due to the green effect and a reintroduction of electric vehicles in the 2000's started to emerge. Many different types of EV's have been produced including hybrid gasoline cars, plug-in hybrid vehicles and battery electric vehicles. Plug-in electric vehicles use chemical energy stored to operate the car, using no gasoline. With new cars emerging only using electric we must look into the energy resources that provide the energy as well as the efficiency of utilities.

There are nine main energy resources: crude oil, coal, natural gas, hydroelectric, nuclear, wind, bio-fuels, solar and geothermal. Crude oil however is the highest produced resource of energy that the world currently uses. The United States is the leader in oil consumption in the world while it is the third largest producer of it in 2011. Out of all consumption of oil only hundredths of a percent go to electricity production, most oil and petroleum use in the United States goes to transportation. If we can replace oil, which has larger fixed costs and larger variable cost to extract, with energies that has lower fixed costs and lower operating costs than producing energy for electric vehicles may be more efficient. The reduction in use of oil and petroleum might have a large positive effect in the United States economy as well as efficient use of resources. Each different resource ranges in efficiency of energy produced and each has different economic costs.

In this paper we will look into if electric vehicles are economically profitable, efficient and beneficial in the long run. This is an important issue to look at due to the amount of resources the United States uses daily and how the reduction in oil use to power cars might be economically beneficial. To see if the use of electric cars will be beneficial we will look into the economic costs of electric vehicles. The different types of energy resources that are used to produce electricity and if they contain beneficial costs. To implement electric vehicle driving there will be a cost of building an infrastructure and an effective way of pricing these products to the consumers. The evaluation and analysis of gathered data will answer the question of whether electric vehicles will be economically profitable and efficient in the long run.

Economic Costs of Electric Vehicles:

All means of transportation have different economic costs associated with them; electric vehicles have many different factors that make up the economic costs of owning and driving one. There are many different types of advantages and positive externalities that driving an electric vehicle might produce. According the U.S. Department of Energy, electric vehicles convert anywhere between 59 to 62% of the electrical energy from the grid to power at the wheels.[1] This is conversion is almost triple what conventional gas vehicles convert up to, thus making the consumption of energy more efficient in use. While looking into overall efficiency we must look into the efficiency of going from fuel to electricity. Electric vehicles release low to no air pollutants when operated and when charged from Co2 emitting sources like coal or natural gas power plants carbon production is typically cut in half rather than gas powered cars. The charging from other power sources could possibly allow for cheaper or low expense travel.

When calculating the economic costs of electric vehicles you must look into the alternative consumption of energy and electricity compared to conventional gasoline. The change of energy resources will result in different spending habits due to a change of transportation; this can be seen not just in use of electric vehicles compared to conventional gas vehicles but the opportunity costs of taking a public transportation train into the city instead of a car. I will examine three different types of electric vehicles due to opportunity cost and consumers behavior of different products, with their initial costs of purchasing them and the electricity they consume to run.

---

[1] "Electric Vehicles." *Electric Vehicles*. U.S. Department of Energy, n.d. Web. 1 Oct. 2012. <http://www.fueleconomy.gov/feg/evtech.shtml>

Fuel efficiency is the process of converting chemical potential energy contained by a carrier fuel and producing it into a kinetic energy or form of work. All different fuel sources have specific energy content that is released when the object is manipulated or burned. We see this process conducted to support our electricity infrastructure that we have in place today. This is important due to all conversion processes of electricity utilities having different efficiency levels, allowing for the highest return of energy production. Solar production has the lowest efficiency rate with starting around 6 percent and water turbines allowing for around 90 percent. The process of energy conversation ratios has to deal with the economic costs of electric vehicles by applying overall efficiency of gas consumption to coal consumption or other natural resources. The use of these resources will affect the grid that powers these cars and change monthly costs of household's utilities.

Each different car's electrical usage depends on the charge-required daily to operate; the first car we will look at is the Nissan Leaf. The Nissan Leaf is the world's top selling electric car, starting around $27,700 USD. The Nissan Leaf uses a 24 kWh lithium ion battery for its full 100+ mile commute, and according to Nissan is warranted up to 8 years or 100,000 miles.[2] The average home in America uses around 25 kWh per day, increasing electricity usage around 50%. At a high rate of 12.5 cents per kWh it would cost the Leaf a $1.50 to $3.00 a day to run. A month worth of driving it 50 miles or less would add the costs of $45 to your electric bill and at the maximum cost it would add $90 dollars with over a 100-mile commute

[2] "VERSIONS & SPECS." *Nissan USA*. Nissan, n.d. Web. Oct.-Nov. 2012. <http://www.nissanusa.com/leaf-electric-car/versions specifications?next=ev_micro.overview.specs.button>.

every day. The 100-mile commute per day would allow this car to be under warranty for 1000 days or 2.73 years (even though it should last longer than 3 years we will say that the car dies when the warranty diminishes completely), averaging out to $10,110 (initial cost of vehicle/years lasted) + $1080 (increase in electric bill per year) equaling to an average cost of $11,190 per year at a 3 year life span.

The second car we will be looking at is the Chevrolet Volt. The Chevrolet Volt is one of the newest electric vehicles to be introduced and has been marketed more than any other one to date. This car starts at the price of $31,645 USD, uses a 16.5 kWh T-shaped lithium-ion battery pack that gets up to 38-miles on a full charge while also using gas to allow it to go to a 380 mile drive. This car is warranted up to 8-years or 100,000-mile battery and Voltec component limited warranty.[3] Computing for the same average home use of energy and pricing as the Leaf, the Volt would cost $1.03 to $2.06 to run each day without the use of gasoline, adding $30 to $61 to your electric bill a month with driving 38 miles a day or less. With a 38-mile commute per day would allow this car to be under warranty for 2631 days or 7.21 years, averaging out to $4,389.16 (initial cost of vehicle/years lasted) + $732 (increase in electric bill per year) equaling to an average cost of $5,121 per year at a 7 year life span. Due to the Leaf being able to drive 100 miles on a charge we must compute the possible prices at the same operating level. This would increase costs by 2.5 times the amount stated above, making monthly costs increase to $75 to $152.50. A 100-mile commute per day would allow the car to be under warranty for

[3] "Models & Specs." *Chevrolet Volt*. N.p., n.d. Web. Oct.-Nov. 2012. <http://www.chevrolet.com/volt-electric-car/features-specs/trims.html>.

1000 days, averaging out to $11,591.57 (initial cost of vehicle/years lasted) + $1830 (increase in electric bill per year) equaling to an average cost of $13,421.57 per year at a 3 year life span.

The last and by far the most aesthetically pleasing car I will be evaluating is the Fisker Karma. The luxurious Karma is a higher end electric car and gas, starting around $96,895 USDA. This car has a 20.1kWh mid-mounted lithium-ion battery with Nanophophate technology that receives up to 50 miles on a full charge without using any gas and up to 300 with gas.[4] The Karma's warranty is 5-year or 60,000 miles on the battery but is expected to last up to 10 years or 100,000 miles. Using the same costs for electric charging as the Leaf and Volt, the Karma would cost $1.25 to $2.51 to run each day from a 25 to 50-mile commute. Increasing your electricity bill from $37.69 to $75.38 a month without the use of gasoline and driving less than 50-miles a day. A 50-mile per day commute under warranty would allow the car to run for 1200 days or 3.29 years, averaging out to $19,379 (initial cost of vehicle/years lasted) + $904.56 (increase in electric bill per year) equaling to an average cost of $20,283 per year at a 5 year life span. At a 100-mile rate this would double prices increasing monthly electricity to $75.38 to $150.76 without the use of gasoline. A 100-mile per day commute under warranty would allow the car to run for 600 days or 1.64 years, averaging out to $58,944.45 (initial cost of vehicle/years lasted) + $1,809.12 (increase in electric bill per year) equaling to an average cost of $60,753.57 per year at a 2 year life span.

[4] "The World Needs New." *Fisker Karma Overview*. N.p., n.d. Web. Oct.-Nov. 2012. <http://onward.fiskerautomotive.com/en-us/karma/overview/>.

These three different cars are unique in all their own ways ranging from a pure electric car to luxurious half electric half gas daily driver. Each one of these cars has different warranties and projected life spans that will last from the range of 3 to 7 years while driving them their max distance every possible day. Out of the three established cars here the Chevrolet Volt has the best cost-benefit analysis compared to the other choices by having a total cost of $35,847 over 7 years with operating without gas if only commuting 38-miles a day. If you want a car that can be operated at a longer commute of 100-miles a day but has a smaller life span, the Leaf will in total cost $33,570 over 3 years and never use any gasoline. The Karma is not a electric car for your average family and might be looked at as a luxurious everyday driving that can commute up to 50-miles a day and costs $101,415 at a 5 year life span. Being able to compare three different electric vehicles at their max distance traveled in one charge and at the 100-mile rate shows the price differences in current products in the market. The three different cars compared all have different specs and different benefits to driving; whether it is a price point, distance traveled or overall style each car has challenges it has to face to be a cost effective car.

The challenges faced or to eventually face with producing and driving an electric car can be problematic. Solely electricity-based cars have a limited amount of range per charge, making long distance driving a problem. The lack of current developments and charging infrastructure only allows electric vehicles to charge at their homes or the 4,756 public electric stations according to the U.S. Department of Energy. In the area of Bloomington-Normal, IL there are currently nine free public charging stations with one being located in the parking lot of Milner Library.[5] This may seem like a large amount of different free options to charge at but compared to the 150,000+ public gas stations there are that is just around 3% of possible fueling stations. The problem of possible charging and barriers to creating a new infrastructure are not the only problems that are faced. Energy transfer in the cold is worse than in the summer or peak driving conditions. This would slow down efficiency of driving and possible problems inside the car with heating, making the use of these cars limited in certain conditions. One of the other possible problems that occur is the use of green energy; with the use of coal or natural gas energy to power these cars we would still not be carbon neutral.

The economic costs of electric vehicles depend on multiple factors, which are exerted from use of them. An increase of utilities through the efficiency of electricity conversion is a topic that must be furthermore looked into, the possibility of increased mining of coal; natural gas drilling or energy turbines could affect the overall gird power. When it comes down to the extra power consumption each person that uses electric cars will have their own marginal benefit and unit elasticity associated with this product. The increasing cost of an electricity bill might allow a person to think its marginally beneficial to them switch away from gas. Later on in the paper I will compare the cost of gas to electricity for driving each day to see if it is cheaper on a small distance driving scale. To find out if using electric resources to

[5] "Electric Vehicle Charging Station Locations." *Alternative Fuels Data Center*. N.p., n.d. Web. Oct.-Nov. 2012. <http://www.afdc.energy.gov/fuels/electricity_locations.html>.

power cars is beneficial we must look into the different types of energy resources used and the most efficient cost beneficial utilities.

The increase of electric vehicles could make a significant impact on the car market and even the energy market that is vital in everyday life. Around 17,000 electric cars were sold in 2011; the Nissan Leaf has been the best seller with 32,000 total on the road. In 2011 there were 13 million total vehicles sold in the U.S., electric vehicles only make up one tenth of a percent. The Chevrolet Volt and Nissan Leaf combined sold more units last year than any hybrid ever did including the Prius. Hopes of in the next ten years an increase to 1 percent of vehicles on the road will be electric. There are currently around 1 billion vehicles on the road in the world and if electric vehicles were to get to 1 percent of all cars that would mean there were 10 million electric vehicles running. The cost of driving electric vehicle is a very important part of choosing if it is economically beneficial for the consumer to choose that over a conventional gas car.

Energy Resources and Efficient Utilities:

The consumption of oil, gas, electricity and other energy commodities play a huge role in the United States in many different ways evident by the daily news, changes in commodity prices and national energy related issues. The importance of finding the most efficient way of using our natural resources is an important issue. The cost of storing large amounts of electricity over time is too costly; therefore the amount of energy demanded is what is produced at that time. If we can limit the use of oil and expand cheaper energy production, we could benefit in the long run. We must look into different electricity generating resources we have to see what ways are most economically beneficial to the U.S.

Currently there are nine main types of energy resources that can be generated into electrical power. Coal, natural gas and oil are the three top fuels burnt to run generators that supply power to the US. Uranium usage in nuclear plants is the second closest, that has high fixed cost but low operating costs. Energy sources like wind, water, and solar power could possibly provide cleaner and cheaper ways to support travel. These renewable energies are used during the day and have very low operating costs too them. The use of electrical charging vehicles may help find balance in pricing of commodities here in the United States as well as improve natural resource usage. The use of electricity as an energy that will power cars as well as other objects could be one of the most efficient usage of our resources. The possibility of using electric cars to help reintroduce energy back into the grid during peak hours could make renewable energies more important by allowing them to be used during peak hours lowering costs. This could possibly decrease the highest used resource usage by allowing storage of energy.

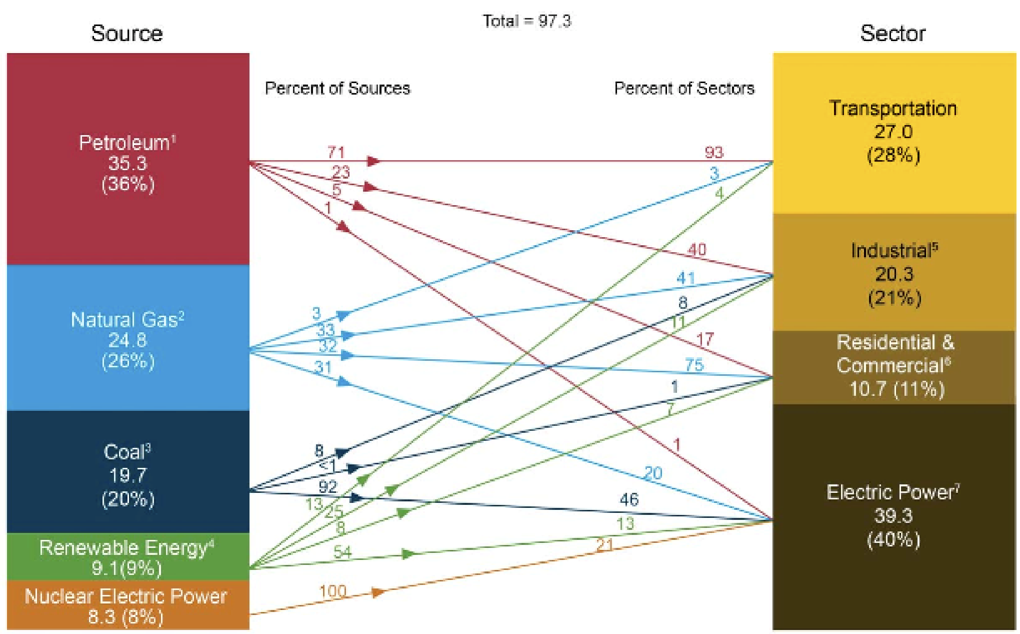
The current resource that the world uses most is crude oil, which is separated into oils, gases and other by products used to operate homes, cars and machinery. According to the EPA "In 2009, world total primary energy consumption was 483 Quadrillion Btu. The United States energy consumption was about 95 Quadrillion Btu, about 20% of the world total."[6] Coal and natural gas are the two

---

[6] "Energy.gov." *Energy Sources*. N.p., n.d. Web. Oct.-Nov. 2012. <http://energy.gov/science-innovation/energy-sources>.

highest used energies that supply power to the grids and our homes. These are used due to having large amounts of coal depositories in the US and large amounts of natural gas reservoirs and the new technology of hydraulic fracturing. According to the EPA 39% of the total energy consumed in America is used for electric power and 27% is used for transportation.[7] This can be seen in Figure 2.0 Primary Energy Consumption by source and sector, 2011 from the EPA's website.

Figure 2.0 Primary Energy Consumption by Source and Sector, 2011
(Quadrillion Btu)



This graph shows the importance of how we use the resources we have currently by showing the consumption in 2011.

Different types of electricity produced have different impacts on the environment do to its generation. Each different type of systems has advantages and disadvantages to the production of energy. The effects of oil drilling can be seen in the BP oil crisis and also the pollution emissions that are given off in everyday

[7] "Energy and You." *EPA*. Environmental Protection Agency, n.d. Web. Oct.-Nov. 2012. <http://www.epa.gov/cleanenergy/energy-and-you/index.html>.

situations. Coal's environmental impact is seen in the mining and the burning of it, there have been acts and plans to reduce the carbons and toxic pollution given off from coal-fired power plants. Natural gas, which is often considered one of the cleanest fossil fuels, still produces carbon dioxide but in less amounts than oil or coal. Nuclear power environmental impacts are caused by accidents that rarely take place like Chernobyl and Fukushima. These impacts can be horrific and life threatening too many people. Other renewable resources give off less environmental impacts than any others source but can only be ran at certain times due to natural production of them. With different techniques of extraction and different environmental impacts all resources must be priced at different levels.

The price of a resources change from one type to another, wither it be a renewable resource to petroleum based product. Each resource has different costs to produce on a per kilowatt-hour basis; this is due to the generation of electricity at the load point of the grid. The overall costs of extraction, emissions and distribution/transmission make up the price at which it is provided to the public. Factors of capital cost of building a structure, fuel costs to run the plant and possible waste are all factors that go into efficiently pricing these resources.

The rank of lowest cost differentiates from area of production and sources I have found. It seems that hydroelectric is the cheapest production of energy, with wind and coal right behind and nuclear right after that. These prices are determined by total system levelized cost, which is the dollar cost per megawatt-hour that must be charged over time in order to pay for the total cost. This is divided by 100 to get the cost per kilowatt hour and then the decimal point is moved over 1 place to the left to get cost in cents per kWh.

Neo-classical welfare economics is the process of adding in externalities or external costs that have to be added to the price of electricity to achieve consumption of resources. These external costs cover health impacts of burning harmful chemicals or emissions pollutants. As well as environment damages that can be not just air pollution but harm to natural environment. These economic losses are not always accounted for in electrical pricing and are external costs. All types of energy production cause externalities to the public. The energy that I have found that produces the less environmental threats and emissions is wind turbine energy. Due to wind energy providing such a low amount of energy for the United States and the world growth must occur in this renewable energy to cut down externalities.

Table 1. Estimated Levelized Cost of New Generation Resources, 2017

Plant Type	Capacity Factor (%)	U.S. Average Levelized Costs (2010 $/megawatthour) for Plants Entering Service in 2017 Levelized Capital Cost	Fixed O&M	Variable O&M (including fuel)	Transmission Investment	Total System Levelized Cost
Dispatchable Technologies						
Conventional Coal	85	64.9	4.0	27.5	1.2	97.7
Advanced Coal	85	74.1	6.6	29.1	1.2	110.9
Advanced Coal with CCS	85	91.8	9.3	36.4	1.2	138.8
Natural Gas-fired						
Conventional Combined Cycle	87	17.2	1.9	45.8	1.2	66.1
Advanced Combined Cycle	87	17.5	1.9	42.4	1.2	63.1
Advanced CC with CCS	87	34.3	4.0	50.6	1.2	90.1
Conventional Combustion Turbine	30	45.3	2.7	76.4	3.6	127.9
Advanced Combustion Turbine	30	31.0	2.6	64.7	3.6	101.8
Advanced Nuclear	90	87.5	11.3	11.6	1.1	111.4
Geothermal	91	75.1	11.9	9.6	1.5	98.2
Biomass	83	56.0	13.8	44.3	1.3	115.4
Non-Dispatchable Technologies						
Wind	33	82.5	9.8	0.0	3.8	96.0
Solar PV[1]	25	140.7	7.7	0.0	4.3	152.7
Solar Thermal	20	195.6	40.1	0.0	6.3	242.0
Hydro[2]	53	76.9	4.0	6.0	2.1	88.9

In this table above it shows that hydropower and wind power are two of the lowest levelized costing producers of energy. The problems with these energies are that they are also renewable which are not always provided in certain community areas. Coal and natural gas resources can be seen a low levelized costs of production and almost make up 46% of the energy the US consumes. To determine the most beneficial use of energy we must look into not just the costs to produce but the other externalities and benefits associated with these energies. The energy produced allows for utilities to be sent to customers and different businesses to supply energy to the possible electric vehicle infrastructure.

Infrastructure Cost and Pricing to Consumers:

Powering stations can be successful if they provide cheaper and cleaner utilities to electric vehicle users; the only problem is that there is a scarcity of powering stations here in America. As stated before there are currently 4,756 powering stations that serve the public on an everyday basis while doing it for free.[8] The minimal amount of powering stations does not allow for a large-scale electric travel on a day-to-day basis. Electric vehicles would have to have a demand for a larger charging infrastructure for it to be economically beneficial to own a car like this.

The Alternative Fuels Data Center, which is hosted by the U.S. Department of Energy has developed an informational guide to explain building and supplying energy through charging stations. The total installed cost estimates depends on the type of station your establishment wants installed and the previous electric equipment and supply you currently have. The station that would be installed will be a regular Level 2 EVSE (electric vehicle supply equipment) or a Level 2 EVSE DC fast-charging station. An estimated cost for a standard Level 2 EVSE is around $15,000 to $18,000 per station with an additional $4,000 to $8,000 per charging unit. The DC fast-charging EVSE unit ranges from $65,000 to $70,000 plus an

---

8 "Electric Vehicle Charging Station Locations." *Alternative Fuels Data Center*. N.p., n.d. Web. Oct.-Nov. 2012. <http://www.afdc.energy.gov/fuels/electricity_locations.html>.

additional $45,000 to $100,000. The AFDC stated, “These prices are expected to trend downward as EVSE production volumes increase.”[9] These prices for charging stations do not take into consideration for government incentives to the owners of these stations.

The cost of a single charging station can be an investment for your establishment by attracting new customers. Charging stations have been seen at multiple different types of areas like, retail stores, parking garages, office parks and government properties. Charging stations in local retail stores can increase possible shoppers by attracting EV drives to shop somewhere they can charge, increasing profits for your establishment. "I go out of my way and plan my trips around public charging stations. You're helping me ... so I'm paying you back with my loyalty and spending my business there," –Lin Murphy[10]. There has been a lot of speculation on how the electric vehicle market will grow and how the available will electric vehicle charging stations are. Two different articles I found about expansion of charging stations are by Frost and Sullivan and Lux Research.

Frost and Sullivan a business research and consulting firm, released a report stating that by the year of 2017 North America will increase the number of electric vehicle charging ports to 4.1 million. “The most common ones, 71 percent will be Level 1 charging stations for home charging which are included in the purchase of a

[9] "EERE: Alternative Fuels Data Center Home Page." *EERE: Alternative Fuels Data Center Home Page*. N.p., n.d. Web. Oct.-Nov. 2012. <http://www.afdc.energy.gov/fuels/electricity.html>.

[10] Yan, Holly. "Public Charging Stations Fuel Desire for Electric Cars - CNN.com." *CNN*. Cable News Network, 01 Jan. 1970. Web. Oct.-Nov. 2012. <http://www.cnn.com/2012/10/24/us/public-car-chargers/index.html>.

car or around $600, followed by level 2, which will account for 27 percent of the installed network (DC fast chargers will only make up a sliver of the total). To go along with the fact that most chargers will be private, nearly 87 percent of all electric vehicles are expected to be charged in residential locations, where they'll be parked in the garage for 10 to 12 hours in a day."[11] They believe the compound annual growth rate will be at 128.12 percent and currently there are over 35,000 homes with charging stations in their garages. The increase in charging infrastructure can be due to current oil prices and move to green living.

Lux Research a technology scouting and market research firm believes that there will be an increase of 1.3 million stations by the year of 2020 which are significantly different numbers over a difference of 3 years. The increase by Lux Research states that there would be an increase to a $1.15 billion cost for this infrastructure. ""Success for EVSE will ultimately follow the success of electric vehicles," said Kevin See, Lux Research Senior Analyst and the lead author of the report. "It's critical for those invested in charging stations to find the applications where there's substantial growth.""[12]

In these two articles we see numbers that both promote growth in the EVSE market but no concrete numbers that we can project to possible electric vehicle drivers. The problem with this infrastructure is due to the demand set by the

---

[11] LeSage, Jon. "4.1 Million Electric Vehicle Charging Stations in Five Years? What?! *UPDATE." *AutoblogGreen*. N.p., n.d. Web. Oct.-Nov. 2012. <http://green.autoblog.com/2012/08/08/4-1-million-electric-vehicle-charging-stations-in-five-years-wh/>.

[12] Falk, Tyler. "EV Charging Stations: $1.2 Billion Market by 2020." *SmartPlanet*. N.p., n.d. Web. Oct.-Nov. 2012. <http://www.smartplanet.com/blog/bulletin/ev-charging-stations-12-billion-market-by-2020/4268>.

consumers, when there is a low amount of electric vehicles on the road there seems to be less interest and supply by the market. To increase the infrastructure of EVSE there must be an increase in electric vehicles in the market place and government spending to subsidize costs for suppliers, to prevent decline in the EV industry. The last federal subsidy for charging equipment was offered in 2010 and was a business quality tax credit up to $50,000 for larger installations. Possible incentives and subsidies can still be found based on state, city or utility eligibility. An increase in EVSE infrastructure could be increased by implementation of charging on a per kilowatt-hour basis.

Charging on a per kilowatt-hour basis can increase businesses demand for charging stations due to the return and or even gain on investment of EVSE stations. All calculations of pricing depend on a per kilowatt-hour basis and what level of electric charging these stations will use. An exact revenue system has not yet been put into a public form but trails of different types of revenue have begun testing. The EV Project is the largest deployment of electric vehicle charging infrastructure, which has set up over 2,600 charging stations in 21 cities. This process began in winter of 2010 and is one project that is testing methods of revenue building.[13] The EV stations are mostly powered by the electrical grid and charge around $2 per hour sometimes upwards of $3.[14] These charging stations will be the first of its kind that

---

[13] "The EV Project." *EV Project*. N.p., n.d. Web. Oct.-Nov. 2012. <http://www.theevproject.com/index.php>.

[14] Yan, Holly. "Public Charging Stations Fuel Desire for Electric Cars - CNN.com." *CNN*. Cable News Network, 01 Jan. 1970. Web. Oct.-Nov. 2012. <http://www.cnn.com/2012/10/24/us/public-car-chargers/index.html>.

charge a price for electricity and will change how free charging currently works. The increase of stations that charge a standard price will allow businesses to see if having these stations will be profitable and attract possible new customers. Each city and station varies in pricing due to the cost of electricity and then increases for revenue. The allowance of revenue for quick charging will be beneficial to the market of EVSE stations due to allowing expansion for producers and suppliers. Current gas stations would be able to supply another source of fuel, allowing electric vehicles to operate in larger settings. A revenue plan for businesses is one of the most important parts to building an electric vehicle-charging infrastructure. This would allow businesses to see that there are benefits for them to supply charging stations to customers. Phasing out free charging stations and introducing pay stations give incentives to businesses with competitive pricing as well as increasing the possible infrastructure that we currently do not have.

Evaluation and Analysis of Gathered Data:

The cost of driving electrically compared to gas could be or is for some people a substantial amount in a residential driving situation. To simulate operating economics between electric cars versus conventional gas cars we will take the Nissan Leaf, which is a solely electric vehicle, and compare it to an average car at a 100-mile range. As stated in the economic costs of electric vehicles section, a month worth of driving it 50 miles or less would add the costs of $45 to your electric bill and at the tops add up to $90 dollars with over a 100-mile commute every day with the Nissan Leaf. The costs of electricity will be compared to the costs of using the amount of required gasoline. We will assume that the average gasoline powered car gets 25 miles per gallon and at a rate of $4 per gallon (which is lower than the national average in the U.S.). At 100 miles a day, 30 days a month at $4 a gallon the grand total of driving is $480 a month (100 miles per day x 30 days per month x $4 per gallon / 25 miles per gallon, 100x30x4= 12000/25=480). Using electric utilities to charge your car for a daily drive at 100 miles will cost you $390 more dollars in a conventional gas car than an electric vehicle.

A possible increase of electric vehicles plugged into the grid during the night would have slight affects towards power supply and usage. Due to the charging of most vehicles being during the night, this would not affect base load hours. This would also encourage lower the pricing of utilities at night. Examples of lower pricing at night can be seen in many industrial manufacturing facilities being open at night due to decreased pricing. The possibility of vehicle to grid charging could decrease the need for running existing plants during peak hours by using the cars supply to generate electricity for your home. Not all costs for electric cars are related to the utilities that are used to power it, emissions impacts also can factor into being beneficial.

The evaluation of the cost of an electric vehicle chagrining station infrastructure must come in the form of a macroeconomic evaluation. A macroeconomic evaluation should look past the individual's decisions and look at the higher up country and government decisions on what to do. To understand what an increase in infrastructure would do to the economy we must look into the costs of building one. As stated earlier in my paper currently the United States has around

150,000 public gas station so I will use this number, as a reference as to a minimum amount of level 2 electric vehicle stations must be needed to operate at a sufficient size. Also earlier in my paper a Frost and Sullivan stated by 2017 North America will have 4.1 million electric charging posts and 27 percent of those will be level 2 stations. These numbers allow me to figure out that there will be 1,107,000 (4,100,000 posts * .27 level 2= 1,107,000 level 2 posts) charging posts and at each of these 150,000 station there will be 7 chargers per station (1,107,000 #of chargers/ 150,000 # of stations= 7.38 chargers per station). The costs associated with this infrastructure will start at $15,000 to $18,000 for the first charging and an additional $42,000 for the other 6 ($6,000 per charger post * 6 additional posts= $42,000) a total of $57,000 to $60,000. The grand total of this project would cost $8,550,000,000 to $9,000,000,000 at 150,000 total stations ($57,000 * 150,000= $8,550,000,000 or $60,000 * 150,000= $9,000,000,000). The production of an infrastructure this big can affect the nations GDP, change in unemployment, rate of growth and more. I personally can't produce the numbers in which an infrastructure like this could change the United State economy I simply do not have the necessary resources or data to conduct it, but I believe that producing a possible nine billion dollar industry could help the economy as well as give the government incentives to help structure something as big as this.

Conclusion:

In the last 10 years the market of automobiles has been changing in a positive direction. This positive direction can be seen by the production of cheaper, higher mile per gallon, and cleaner emission cars. Electric vehicles have started to gain growing interest again since the downfall of them in the early 1900's. This interest has led to multiple different types of cars that run off of pure electricity or an electric motor with gas as a backup. One of the downfalls that electric vehicles like the Nissan Leaf face consist of is the distance that they can travel per charge, which range up to 100-miles off a full charge. The distance issue has also lead to problems with the scarcity of charging stations and relative pricing. For electric vehicles to be effective there needs to be an increase in government subsidies to allow the growth of potential EVSE charging stations. The increase in infrastructure needs to occur; with emerging charging stations possible revenue structure can be built allowing companies and recharge stations to profit off of their investments.

There are two main outcomes for the electric vehicle market that could happen in the next ten years. These two outcomes are increased interest in the market of electric vehicles or a plateau/decrease resulting in the same outcomes as the early 1900's. These two outcomes solely depend on what is done in the future and if people believe electric vehicles in the long run will be economically profitable, efficient and beneficial.

I believe that there is a great possibility that there will be an increase in interest in all fields that deal with electric vehicles, charging stations and pricing of utilities. After all of the information I have read, gathered and computed I believe that electric vehicles can be economically profitable, efficient and beneficial in the long run. To the consumer electric vehicles save a large amount of money of gas per month if they drive in the range of 50 to 100 miles per day. 100 miles may seem a short range but the average person drives around 30 miles a day in the U.S. allowing for a increase of daily habits by 3 times the average amount. If larger distances than 100 miles need to be driven then an infrastructure larger than The EV Project must be implemented. The EV Project is a great start to expanding electric vehicle usage but more businesses, government establishments and public resources need to back this cause, by supplying stations and making a profit of their own. The process of building an infrastructure as big as the current gas one we have today could cost up to $9 billion dollars but could change the macro economy we currently have today. The increase in interest with business will help expand profitability as well as supply the increasing demand for electric vehicle charging. The possible increase of growth in the electric vehicle market could help decrease the environmental economic impact as well as help change the demand of peak load pricing. Electric vehicles can be beneficial to the environment, efficient if the proper infrastructure is developed and economically profitable to the consumer by reducing overall costs or travel.

Bibliography:

Nersesian, Roy L. "Energy for the 21st Century: A Comprehensive Guide to Conventional and Alternative Sources." N.p., 6 Dec. 2006 Web. Oct.-Nov. 2012.

Sandalow, David. *Plug-in Electric Vehicles: What Role for Washington?* Washington, D.C.: Brookings Institution, 2009. Print.

Internet Resources:

"Electric Vehicles." *Electric Vehicles*. U.S. Department of Energy, n.d. Web. 1 Oct. 2012. <http://www.fueleconomy.gov/feg/evtech.shtml>

"VERSIONS & SPECS." *Nissan USA*. Nissan, n.d. Web. Oct.-Nov. 2012. <http://www.nissanusa.com/leaf-electric-car/versions specifications?next=ev_micro.overview.specs.button>.

"Models & Specs." *Chevrolet Volt*. N.p., n.d. Web. Oct.-Nov. 2012. <http://www.chevrolet.com/volt-electric-car/features-specs/trims.html>.

"The World Needs New." *Fisker Karma Overview*. N.p., n.d. Web. Oct.-Nov. 2012. <http://onward.fiskerautomotive.com/en-us/karma/overview/>.

"Electric Vehicle Charging Station Locations." *Alternative Fuels Data Center*. N.p., n.d. Web. Oct.-Nov. 2012. <http://www.afdc.energy.gov/fuels/electricity_locations.html>.

"Energy.gov." *Energy Sources*. N.p., n.d. Web. Oct.-Nov. 2012. <http://energy.gov/science-innovation/energy-sources>.

"Energy and You." *EPA*. Environmental Protection Agency, n.d. Web. Oct.-Nov. 2012. <http://www.epa.gov/cleanenergy/energy-and-you/index.html>.

"EERE: Alternative Fuels Data Center Home Page." *EERE: Alternative Fuels Data Center Home Page*. N.p., n.d. Web. Oct.-Nov. 2012. <http://www.afdc.energy.gov/>.

LeSage, Jon. "4.1 Million Electric Vehicle Charging Stations in Five Years? What?! *UPDATE." *AutoblogGreen*. N.p., n.d. Web. Oct.-Nov. 2012. <http://green.autoblog.com/2012/08/08/4-1-million-electric-vehicle-charging-stations-in-five-years-wh/>.

Falk, Tyler. "EV Charging Stations: $1.2 Billion Market by 2020." *SmartPlanet*. N.p., n.d. Web. Oct.-Nov. 2012. <http://www.smartplanet.com/blog/bulletin/ev-charging-stations-12-billion-market-by-2020/4268>.

"The EV Project." *EV Project*. N.p., n.d. Web. Oct.-Nov. 2012. <http://www.theevproject.com/index.php>.

Yan, Holly. "Public Charging Stations Fuel Desire for Electric Cars - CNN.com." *CNN*. Cable News Network, 01 Jan. 1970. Web. Oct.-Nov. 2012. <http://www.cnn.com/2012/10/24/us/public-car-chargers/index.html>.

"U.S. Energy Information Administration - EIA - Independent Statistics and Analysis."*U.S. Energy Information Administration (EIA)*. N.p., n.d. Web. Oct.-Nov. 2012. <http://www.eia.gov/>.

"History of Hybrid Vehicles." *New Hybrid Reviews, News & Hybrid Mileage (MPG) Info*. N.p., n.d. Web. Oct.-Nov. 2012. <http://www.hybridcars.com/history/history-of-hybrid-vehicles.html>.

"Economic and Emissions Impacts of Electric Vehicles." *An Energy Policy, Climate Change, and Alternative Energy Community*. N.p., n.d. Web. Oct.-Nov. 2012. <http://theenergycollective.com/ansorg/51761/economic-and-emissions-impacts-electric-vehicles>.