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The Future of Transportation Alternative Fuel Vehicle Policies In China and United States

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ABSTRACT

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Jiyi Lai

The number of passenger cars in use worldwide has been steadily increasing. This has led to an increase in greenhouse gas emissions and other air pollutants, and new efforts to develop alternative fuel vehicles to mitigate reliance on petroleum. Alternative fuel vehicles include a wide range of technologies powered by energy sources other than gasoline or diesel fuel. They use electricity, biofuels, and other alternative energy sources. Governments around the world are working to encourage the development and adoption of alternative fuel vehicles, including production mandates, tax subsidies, and other incentives. This paper discusses and compares the programs and policies to encourage alternative fuel vehicles adoption in the U.S. and China, and finds more similarities than differences in their approaches.

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Introduction

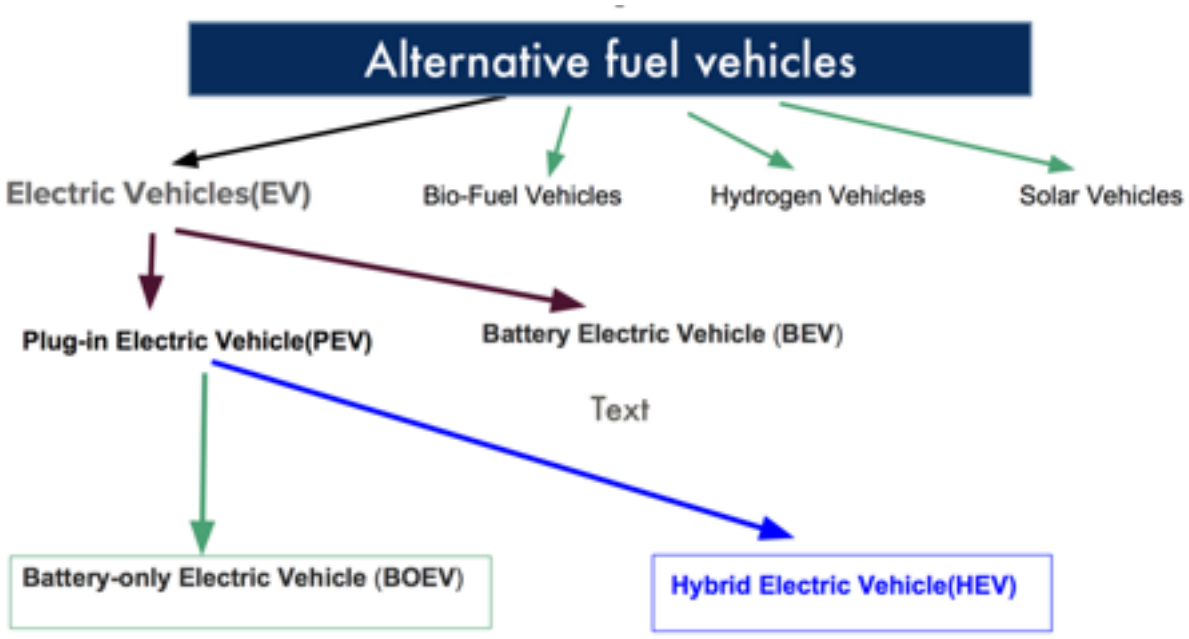
The number of passenger cars in use worldwide has been steadily increasing (Holmberg, Kenneth). This has led to an increase in greenhouse gas emissions and other air pollutants, and new efforts to develop alternative fuel vehicles to mitigate reliance on petroleum. Governments around the world have adopted a wide variety of programs and policies to encourage the development and adoption of alternative fuel vehicles, including production mandates, tax subsidies, and other incentives. In order to accelerate the deployment of alternative fuel vehicles, it will be critical to understand and evaluate these public policy measures. This paper discusses and compares the programs and policies to encourage alternative fuel vehicles adoption in the U.S. and China.

Background

Alternative fuel vehicles include a wide range of technologies powered by energy sources other than gasoline or diesel fuel. They use electricity, biofuels, and other alternative energy sources. Interest in these alternative technologies has been motivated by increased concerns about greenhouse gas emissions as well as future oil prices. According to the California Energy Commission, the most common alternative fuel vehicles on the road today is the electric car, also known as a BEV or Battery Electric Vehicle. BEVs use electricity stored in batteries to power the vehicle. The California Air Resources Board (CARB) describes the BEVs as having no tailpipe emissions. This is due

to the fact that they have no exhaust pipe emission when they are operating. Batteries in the BEVs have lead acid accumulators as well as lithium ions.

In addition to BEVs, there are two other major types of alternative fuel vehicles: (1) HEVs – Hybrid Electric Vehicles—that operate on both gasoline and electricity, and (2) FCVs – Fuel Cell Vehicles. Hybrid electric vehicles have several advantages. Companies have focused on developing mid-sized, heavy and plug in hybrid vehicles. For the purpose of this paper, I will focus on electric vehicles (EVs). EV refers to an electric-



driven vehicle that uses traction motors for propulsion. An EV can be powered via a collector system like a charge station or a power outlet from sources that are off the car or an inbuilt battery or generator that is made to convert gasoline to electricity. There

are diverse EV's across the globe today ranging from water vessels, buses, trains, and passenger cars (Høyer 65). Notably, EVs came into the market in the mid-19th century, a time when people preferred electricity as the sole source of motor vehicle propulsion. EVs provided a particular level of comfort, class, and ease that the gasoline-powered vehicles could not provide at that point in time.

Electric vehicle technology came into realization in 1827, a time when a Slovak-Hungarian priest made the first electric motor which had a commutator, rotor, and stator, which he used the following year to power a small-sized car (Høyer 67). A Dutch professor developed a small-scale electric car in 1835 and also an American blacksmith created a toy electric locomotive in the same year that used primitive electric motor power. In 1838, a Scottish man developed an electric locomotive, which travelled up to 6 kilometers per hour (km/h). In 1840, the U.S. and England granted patents to inventors who brought the idea forward that electricity could power locomotives by using the rails as conductors of electricity.

Rail transport and electric cars gained popularity at the beginning of 20th century, and commercial automobiles had the majority of the market. Switzerland, lacking domestic fossil fuel resources, was forced to integrate electrification into its rail network. Several factors contributed to abandoning EVs in the 20th century, for instance, improvements in road transport that called for a broader range that that EVs offered and large pe-

troleum reserves in Oklahoma, California, and Texas (Høyer 66). Expanded oil production made gasoline more readily available and affordable thus, rendering internal combustion powered vehicles more cost-effective as compared to the EVs. As a result, Henry Ford initiated the mass production of gasoline-driven vehicles that reduced the price of petroleum-driven cars in comparison to their EVs counterparts. Various firms in the 1930's partnered to buy out all electric trams that were in the United States to destroy and replace them with buses powered with gasoline. All these factors led to the closure of the EVs manufacturing.

Production of Electric Vehicles

EV batteries are made from nickel-iron, zinc-chloride, nickel-zinc, and lead-acid. Additionally, the battery and electric propulsion system typically account for up to 40% of the car weight, while, in a gasoline-powered car, the coolant systems, engine and other power generating devices make up only 25% of the total weight of the car.

The most commonly produced EVs are the hybrid variety, which have two inbuilt power generators, one is electric and the second one is an internal combustion engine. Each is designed to operate under the most suitable conditions. More specifically, the automobile utilizes electric power for stop-and-start driving at low speeds while gasoline power is used for highway distances and speeds. The electrically powered motor en-

sures efficient use of gas and mitigates pollution while the gasoline motor prevents unnecessary stopovers to recharge the battery.

In the last few decades, there has been growing concern with the effects that petroleum based products have on the environment, renewing interest in electric vehicle technology that was abandoned many years prior. The emissions of EVs are a function of the technology and fuel that is used to generate the electricity, and it is usually stored in a battery, flywheel or even super capacitors. Internal combustion engines derive their energy from non-renewable fossil fuels, while EVs rely on battery charging or regenerative braking (recovering energy during braking to be stored in an on-board battery).

Over the past several years, the number of EV models available on the market has increased dramatically and there are growing numbers of EVs on the road. By 2015, Nissan sold over 200,000 Nissan Leafs, making it the top-selling, highway-capable EV worldwide. The Tesla Model S ranked second with more than 100,000 vehicles sold. By May 2015, more than half a million EVs had been sold globally, and at that time the U.S. had the largest fleet globally with around 335,000 EVs which represented around 40% of the entire global stock. Notably, California had more than 143,000 EVs, which represented 46% of all EVs in the United States.

There are different car brands in the United States that have manufactured diverse models of electric cars in order to suit the needs of their consumers. For instance, Chevrolet

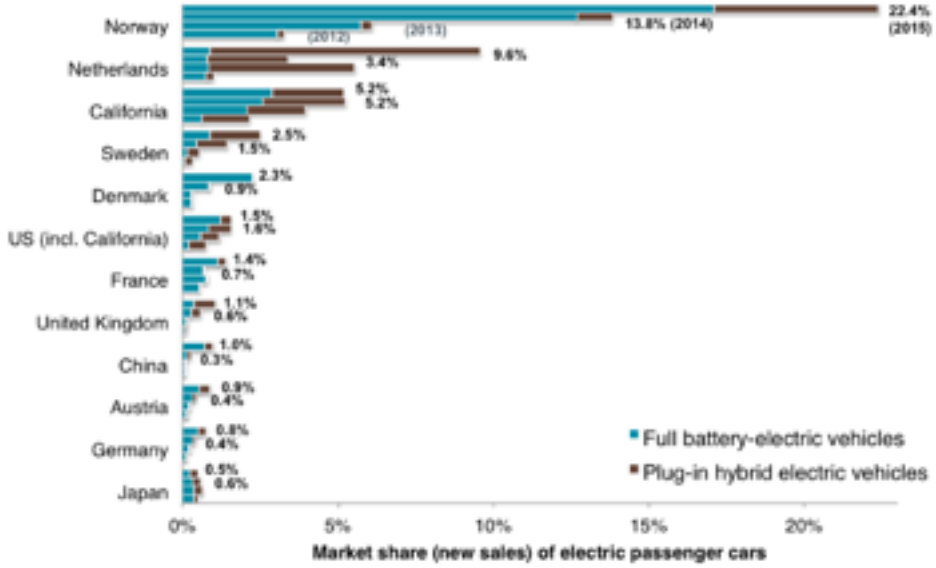
has two models on the market: Chevrolet Volt (1st & 2nd generation) and Chevrolet Spark which recorded sales of 105,076 and 7,032 units respectively as of September 2016. Ford is also a leading producer of EVs and has several models on the market, like the Ford Focus Electric, Ford C-Maxi Energi, and Ford Fusion Energi.

Toyota has also been producing electric vehicles, including the Toyota Prius PHV and Toyota Prius Prime which sold out 42,345 units by September 2016. Models by BMW include BMW iPerformance, BMW i3, BMW i8, and BMW X5 xDrive40e while models by Mercedes Benz are Mercedes-Benz GLE 550e, Mercedes-Benz S 500 e, and Mercedes-Benz B-Class Electric Drive. Car models from Tesla Motors are Tesla Model S and Tesla Model X.

Less common EVs car models include the A3 Sportback e-tron from Audi Motors, Sonata PHEV by Hyundai, and Bolloré Bluecar by the Italian Vehicule Électriques Pininfarina Bolloré. Other EVs include; Volvo XC90 T8 by Volvo, Porsche Cayenne S E-Hybrid, Volkswagen e-Golf, Kia Soul EV, Cadillac ELR, Porsche Panamera S E-Hybrid, Fiat 500e by Fiat, Mitsubishi i, and Smart ED by Daimler AG.

Alternative Fuel Vehicles Versus Traditional Vehicles

Since 1990, GHG emissions in the United States have increased by around 7% each year, although emissions tend to fluctuate due to the ups and downs in the economy and fuel prices among other factors. For instance, in 2014, GHGs emissions increased sig-



Share of new plug-in electric vehicles, 2012-2015

nificantly as compared to the levels of the previous year. The increase is primarily attributable to the increase in the number of gasoline cars in the United States combined with an increase in the mileage of the cars. According to the U.S. Environmental Protection Agency (n.p), 26% of the GHGs emissions in the country are attributed to the transport sector. The emissions come from burning fossil fuels for ships, cars, planes, trucks, and trains because more than 90% of the fuel used in the transport industry comes from crude oil-based products like gasoline and diesel. Besides, the dynamic environmental responsiveness, innovation, support from the government, acceptance from the consumers, investments by original equipment manufacturer (OEMs) and the viability of finances are paving the road for the manufacturing of EVs. Albeit, it is quite clear and elaborate that the EVs have a promising future, it is going to be quite hard to draw close to the gasoline cars since they have existed for over a century now and have

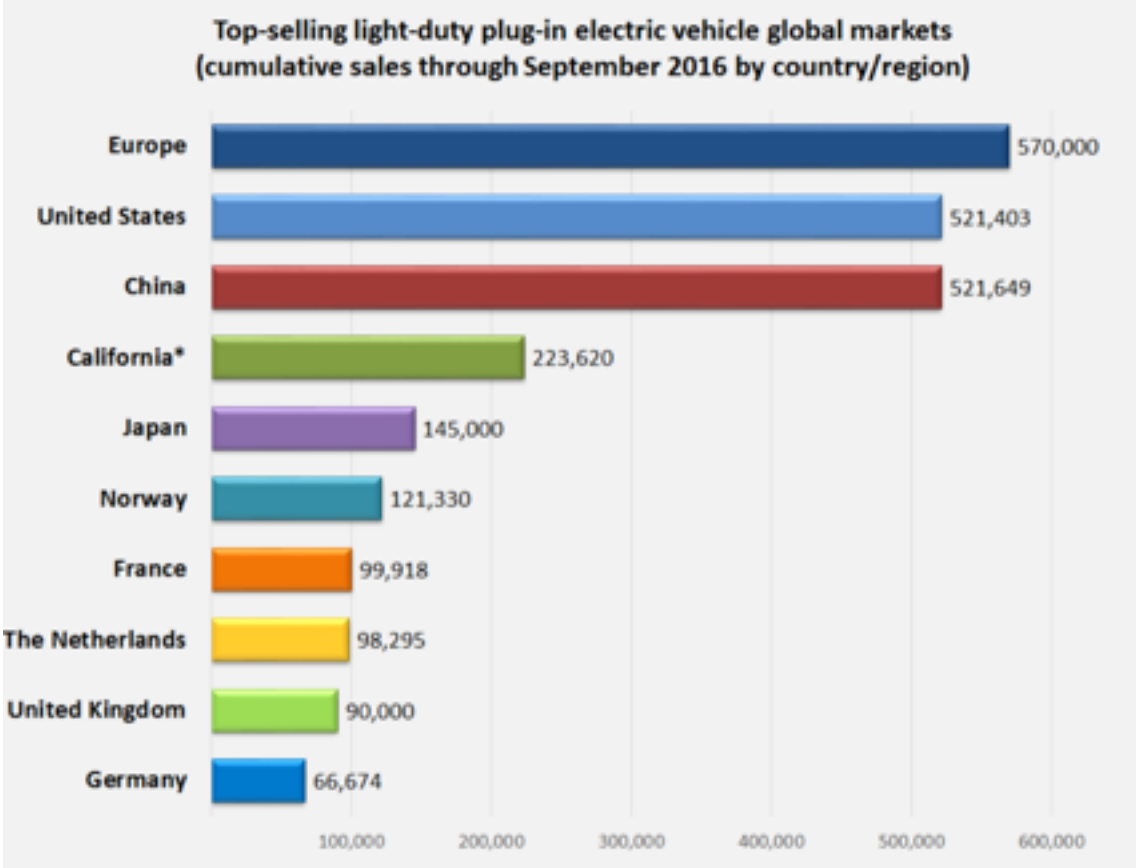
gained worldwide usage and recognition. The global EV market reached a major milestone in the latter half of 2015 when more than 500,000 electrical vehicles were sold.

There has been a sharp increase in the production of alternative energy vehicles all over the globe because the demand for EVs is growing fairly rapidly throughout the world over the years. 'Retrieved from Lim et al., 147

The figure above illustrates the annual sales of EVs from 2012 to 2015 in several countries (and California).

Sweden, Norway, the Netherlands, and Denmark are far ahead of the United States in terms of EV market share. China experienced a large increase in the total number of sales and even surpassed a number of world markets. Norway is the worldwide leader in terms of EV market share (more than 22%), and plans to ban petroleum powered cars by 2025. For two consecutive years (2014 and 2015) the sales in both Denmark and China have tripled the sales of the past year.

Cumulatively, the Europe has the highest number of EVs with 570,000 vehicles, followed by the U.S with 521,403 vehicles, China with 521,649 vehicles, Japan with 145,000 vehicles, and Norway with 121,300 vehicles, as illustrated by the figure below.



Retrieved from Zhou et al., 780

Due to the increase in production of EVs in the world, some countries have decided to ban the usage of gasoline cars and stipulated an ultimatum for the bans. For example,

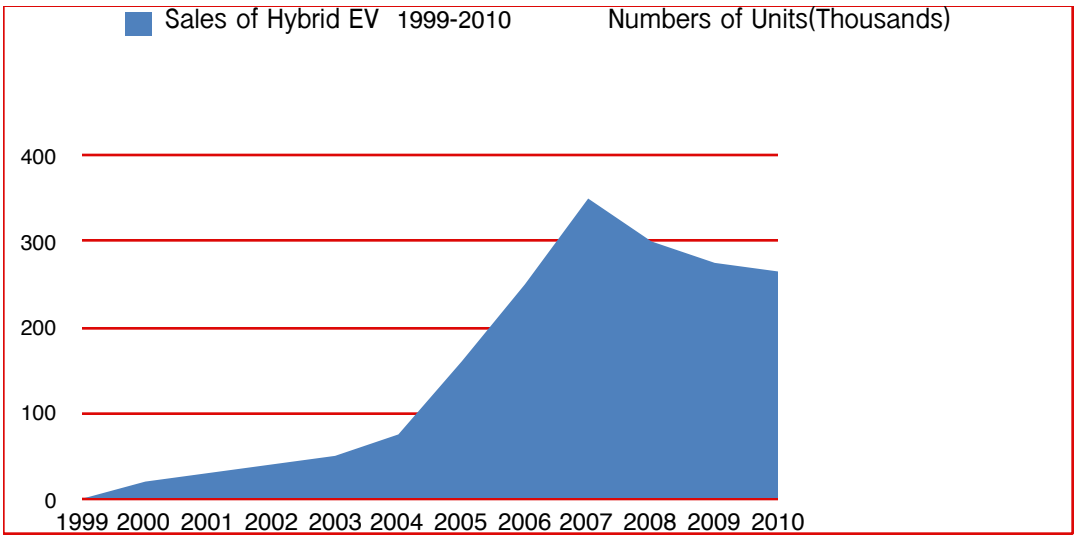
Norway, India, and Netherlands plan to ban gasoline cars by 2025, while Germany plans to ban them by 2030 (Taft n.p).

Though China's market share is only 1% of the global market, it sold more EVs in 2016 than the U.S. China offers hefty government incentives to the consumers of EVs, thus, it possesses a major market for commercial EVs such as buses and vocational vehicles. Surprisingly, commercial EVs account for as high as 40% of the total EVs sales in China.

Source: U.S. Department of Energy, National Renewable Energy Laboratory

China Policy

Both China and the U.S. are pioneers in alternative fuel vehicles. China is the largest market for alternative fuel vehicles with total sales of over 733,000 units as of mid-2016. This is inclusive of passenger cars, buses and trucks. China is projected to account for over 50% of the total electric bus sales by 2020. The Chinese government



has been pushing for electric vehicles as a way of reducing smog pollution in Chinese cities. This move helped quadruple sales last year. In China, the maximum subsidy by the government for the purchase of an EV passenger car about $6,740. License plates in big cities such as Shanghai and Beijing are very expensive and limited. Many cities offer different incentives like free parking spaces and free license plates for EVs.

Car manufacturers have also been encouraging the adoption of alternative fuel vehicles. They are now offering customers free home chargers. Shopping malls are also installing chargers to encourage shoppers to stay longer, while they charge their vehicles. An often overlooked reason for the adoption of alternative fuel vehicles is the fact that currently, several manufacturers are producing quality electric vehicles and not so long ago it was not the case. Many Chinese automakers now sell electric vehicles with ranges of up to 300 kilometers.

Some manufacturers use existing models in their line-up as the basis for their electric derivative, whereas others have built entirely new prototypes from the ground up. Many Chinese start-ups, however, face closure if the government imposes their new guidelines for electric vehicle industry. These guidelines impose tougher technology standards on automakers and would limit the number of manufacturers to a paltry 10. This is aimed at pushing out weak start-ups according to a senior executive in the state-backed auto manufacturer's association.

China passed the U.S. late last year, becoming the biggest market for electric vehicles. The Chinese government aims to increase electric vehicle sales to 3 million units a year by 2025. This is ten times the current amount of sales. Notably, close to 90% of the manufacturers developing EV technologies currently may still not meet the standards set in 2 years. Subsidies in the EV sector are planned to be phased out by the Chinese government eliminating incentives for new companies depending on the reliefs to achieve profitability.

The Chinese government's support for the use of EVs has four goals which are to (1) curb air pollution in the cities, (2) reduce oil dependence from the Gulf, (3) form a globally acclaimed industry that would create employment and foreign currency, and (4) curb carbon emissions. China's target sales were 500,000 EV's by 2015 compared US's 1 million EV target within the same the period and 5 million by 2020.

China created a plan that would see them get ahead of the rest of the countries in the race to become a world leader in the manufacture of electric and hybrid vehicles. As much as the reports show China's efforts to reduce emissions, replacing a fuel car with an electric one of the same size would reduce greenhouse gasses by 19%. This is due to China's 75% of electricity is produced using coal. The government in 2011 gave incentives on electric vehicle's of close to $9,281 compared to US's $7,500. The subsidies' amount was set to be slashed after 50,000 units were sold in China.

In September 2013, the National Development and Reform Commission and industry ministries made a joint announcement that stated that the government of China would give a maximum of $81, 600 for electric bus and $9, 800 for the all-electric private vehicle. Electric and hybrid vehicles sales were expected to reach almost 80,000 units by December 2014.

China Industrial Association of Power Sources had expectation of reaching 200,000 EVs sales in 2015 and to 400,000 units by 2016. The China Association of Automobile Manufacturers (CAAM) reviewed downwards its target sales to 400,000 units. This is after the government subjected penalties on several automakers for corrupting the subsidy program out of an estimated 10 billion Yuan. Commuting distances in China are relatively short as intercity driving is very minimal and cars move at low speeds because of traffic congestion. All these facts work in favor of electric vehicles.

U.S. Policy

The U.S. federal government has also encouraged the adoption of alternative fuel vehicles usage in U.S. As a result, vehicles sales in U.S. reached 522,519 units. The U.S. and China also lead in terms of plug-in electric vehicle sales. This represents a 29.2% of the worldwide market for light-duty plug-in electric vehicles. This data is as of September 2016. By June 2016, there are more than 223,000 registered plug-in electric ve-

hicles in California that in turn made it the leading plug-in car market in U.S. (Clark-Sutton et al. 51).

Chevrolet Volt leads the total sales in United States of plug-in hybrid with over 105,000 units and Nissan Leaf all-electric car follows with 98,829 sales. Tesla has sold 84,561 units coming in third in sales. These numbers are expected to increase in future years. This will have implications for the car market and beyond.

This growth means that electric vehicles will represent a quarter of the cars being driven on the road by 2040. An estimated 13 million barrels a day of crude oil will be saved. Lithium-ion battery cost has already dropped by 65% since 2010 reaching 350 per kWh last year (Clark-Sutton et al. 53). It is expected that EV battery costs to be well below $120 per kWh by 2030 and to fall further after that as new chemistry come in.

President Barrack Obama addressed the State of the Union and placed a US goal of becoming the first nation with one million electric vehicles by 2015 to be driven on the state roads. However, this goal, according to industry observers seems unattainable due to the slow rate of sales EVs. The US secretary of energy, Ernest Moniz, cited that the President's goal may not be achieved until 2020.

President Barrack Obama has pledged $2.4 billion in grants aimed to support next-generation electric vehicles and battery development. He also pledged $400 million for the evaluation and demonstration of plug-in hybrids as well as other technology concepts (Clark-Sutton et al. 55). The Chinese government also shows determination to add public charging stations, a project the government neglected till early 2016. By June there was 65% rise in public charging stations in China. It was recorded to be more than 85,000.

In the U.S., the new plug-in EV's tax credit is $2,500 and an additional $417 gets awarded for every battery capacity kilowatt-hour for more than five kWh. The total credit amount permitted for a new EV is $7,500. In 2016, a research done in University of California argues that 30% of the total plug-in electric sales was as a result of the federal tax credits.

In the US, not until 2010, when it got easier to buy and install a charging station at home due to a 50% tax credit and the maximum of $2,000 for each station. For larger installations, businesses can get credits up to $50,000. In 2016, the US government announced $4.5 billion in grants for the public charge stations and other projects. Major goals focused on for the next five years to strengthen plug-in EVs making it able to fight for a share in the automotive industry include cutting the price of batteries to $125/kWh from the current price of $500/kWh.

Moreover, they focus on cutting the electric drive system costs to $8/kWh from $30k-Wh as well as eliminating almost 30% of the car weight. Achieving these goals will help in the automotive propulsion battery development that has five-times the current range capacity. It will cost a fifth of the current lithium-ion battery. That's good news since they aim at reducing the operating costs and purchase costs too to the level of an internal combustion engine.

A report by the U.S. Department of Energy (DOE) in early 2014 pointed out successes that had been achieved. Among them was the breakthrough that the DOE team of research and development achieved by reducing costs of batteries 50% to $325/kWh compared to 2010 costs. Customer acceptance also grew nearly doubling sales of 2012. Another of their successes was that by the first of the Workplace Charging Challenge, over 40 US employers pledged the provision of charging access points at over 150 sites.

The U.S. Army previously said that it would lease at least 4,000 NEV's in a span of 3 years that it will use the bases for patrols and be transporting people around the base camp. By March 2009, the Army had received 6 Electric Vehicle's with rest coming in the period remaining. After the US-China Electric Vehicle Forum in 2009, the two countries unveiled the China-US Electric Vehicles Initiative. The initiative contains building demo projects in several cities, creating technical maps and developing common standards.

This indicates that the Chinese and U.S. governments are determined to promote the adoption of EVs in their markets. Several states in America are establishing fee exemptions and incentives for EVs. Similar to Chinese government, US is also offering high-occupancy vehicle lane access as well as offering free car parking without consideration of occupancy rate. For example, the Clean Vehicle Rebate Project (CVRP) in California was developed to improve the zero-emission vehicles production.

Comparison of Alternative Fuel Vehicles Policies and Incentives

Policies and incentives in China and the U.S. have several similarities. In the U.S., the Energy Improvement and Extension Act of 2008 provided tax credits to the new plug-in electric vehicles. Later it was the American Clean Energy and Security Act of 2009 (ACES) that granted tax credits.

ACES defines an electric vehicle as a vehicle that gives propulsion energy from at least 5kWh traction battery and utilizes an off board energy source in recharging such battery. The current plug-in electric vehicle credit will act as the electric automaker for more than a year beginning after the date that the automakers will have 200,000 units sales in U.S. The successful electronic vehicles will qualify for 50% of the credit when bought in the initial two-quarters of the period of phase-out and half of that if credit gets purchased in fourth and third quarter of the phase-out period.

The Chinese government reported that they had embarked on a program that will see the government give incentives for private electric vehicles of up to $9,281 and the plug-in hybrid in five cities would receive incentives of $7,634. The subsidies will then be reduced as 50,000 units are sold. This is quite small compared to the number of units one has to sell in the U.S. for the subsidies to be scrapped which stands at 200,000 units.

Charging stations were to be put up in Shanghai, Beijing, and Tianjin. In 2008, with approximately 2,100 charging stations, the government of China set a goal of increasing this number to 500,000 charging stations by December 2011. The Chinese State Council has a plan in 2012 of putting up a new energy vehicle as well as a national energy-saving industry. The target of the program was at 500,000 new charging units by December 2015 and to project to 5 million units by 2020.

In the U.S., both the electric vehicle (Nissan Leaf) as well as plug-in hybrid (Chevrolet Volt) qualify for the $7,500 maximum tax credit. As a result of its smaller capacity of battery (5.2kWh), the Toyota Hybrid Plug-in hybrid qualifies for a $2,500 tax credit. Research suggests that the tax incentives have increased interest in electric vehicles.

States have also been offering incentives to promote the uptake of electric vehicles. The state of California developed the Clean Vehicle Rebate Project (CVRP) to encourage electric vehicles sales. Some of the vehicles that would qualify for the CVRP are battery electric vehicles, plug-in hybrid electric, fuel cell and neighborhood electric vehi-

cles.[1] The incentive for business owners and individuals who lease or buy a new electric vehicle starts at $5,000 and will be reduced later to $2,500.

The U.S. government, in the FY 2015 budget added a provision that would see an increase in tax credit to plug-in electric vehicles to $10,000. This is a $2,500 increase from the current $7,500. This new max credit would, however, not include luxury vehicles with a price tag past $45,000

By May 2010, Chinese car manufacturers created about 10 prototypes of high-speed, all-electric vehicles with plans for mass production. The 5th year plan of Chinese insists on encouraging of innovations in the development of new energy vehicles and assist in the uptake of the use of fuel cell vehicles, plug-in hybrids, as well as electric vehicles. PricewaterhouseCoopers stated that new alternative fuel vehicles will rise to around 1.4 million units as of 2020. This figure is projected to increase by 2025 to about 3.75 million units. To show its determination towards increased uptake of EV's, the Chinese government in late 2015 planned to put up a charging station network countrywide. These are in its attempt to sort the demand power of 5 million units as of 2020.

The countrywide project aims to have charging stations on inter-city highways, business districts and public spaces. The plan requires residential developers to include

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[1] Neighborhood Electric Vehicles are the electric vehicles that usually built to have a top speed of 25 miles per hour (40 km/h), and have a maximum loaded weight of 3,000 lb (1,400 kg). *AutoblogGreen. 2009-02-06. Retrieved 2010-06-09.*

charging spots or assign them points during construction of residences. It is also required that not less 10% of parking spaces in public parking areas should be fitted with charging spots. The plan also indicates that for about 2,000 EVs, there should be about one charging station. The Tesla Motors in the last 2015 quarters talked with the government of China that may make it develop its electric vehicles in its country. Tesla's production in China could drastically reduce the prices of their models by a large margin. Currently the company's Model S prices start at about $76,000 in the U.S. while in China the price starts at a mind boggling $106,000.

The U.S. Treasury Department laid out a proposal that would change the existing tax credit to a rebate which will be available at sale point claimable by the dealers and passed on to customers. This proposal aimed at removing the 200,000 unit capped per automaker which phases out over a span of 1 year. Despite the U.S. President's unsuccessful proposal to raise credit to $10,000 in 3 of his annual budgets, it was included again in the budget of the year 2016. The EV Everywhere Challenge that is among the US Department of Energy's Clean Energy Grand Challenges as well as aim at solving US's essential energy challenges as well as minimize the clean energy technology cost. The Department of Energy has a vision that the 5-year cost of ownership of many electric vehicles that will be almost similar if not comparable to internal combustion engines of the similar size.

The new Joint Center for Energy Storage Research (JCESR) is a group of 5 Energy Department national labs, five universities, and four private-sector companies. The Department of Energy is providing $120 million over five years to the JCESR with the aim of making EV's available and more accessible to customers. Competitive solicitations upwards of $1.9 million in funds of government were released by the Energy Department for the advanced batteries manufacture along with other related drive elements. This is part of the *American Recovery and Reinvestment Act*.

In China, though, the goal to sell 160,000 units in 2014 it was not achieved. However, sales topped 74,763 units a 324% jump from 2013. This indicates that as much as the set target was unfortunately not achieved, a significant rise in sales of electric vehicles was witnessed. If both countries (US and China) maintain their momentum of popularizing alternative fuel vehicles, the sales might continue steadily and hopefully hit the goals set by the two countries.

Funding for startups is also a sure way of increasing quality of new energy vehicles. This will also bring about competition, which will aid in the reduction of prices of units. Policies in the two nations all aim at maximizing electric vehicles production as well as pushing its sales being at par with engine vehicles' internal combustion.

Both governments in China and the U.S., have reaffirmed their efforts to invest in the new energy vehicle industry with the pledging large amounts of cash which are to be

pumped into the industry. The state council of China provided strict orders to the local governments in regards to restriction of sales or new energy vehicles usage. The foreign car manufacturer's law states that they are required to have a joint venture with a Chinese company for car production domestically. In Public Security ministry, the Traffic Management Bureau announced the new green license plates introduction for new energy vehicles identification. This will be a clear distinction compared to the country's standard blue plates[2]. The special plate's objective is to assist in enforcing preferential policies on cleaner cars. It will assist curb emissions as well as reduce traffic flow.

Global Perspective: Reasons Governments Support EV Initiatives

Electric vehicles are the dominant type of alternative fuel vehicles. Both the U.S. and Chinese governments have invested substantial amounts of resources and time in developing the market for electric vehicles. Most states offer some incentives on new energy vehicles. This consists mainly of tax cuts and exemptions (countries such as Belgium and Netherlands) and bonus payments and premiums (Spain and Portugal) for electric vehicle customers. In Europe, the introduction of incentives for fuel efficiency has got support from the car industry as well. The Government relief tax on plug-in electric vehicles has been recognized globally and in turn adopted by central as well as local

[2] Standard blue plates are the normal color for license plates for all passenger vehicles.

governments as a monetary incentive of buying a plug-in electric vehicle for EV consumer.

Battery sizes and vehicle range are factors considered when determining the amount of tax relief on an electric vehicle. The Chinese government's aim of offering various incentives on electric vehicles were among others to curb the air pollution menace, cut its dependence on oil, provide employment for their citizens and also to create foreign currency for the country. In India, the government in early 2013 said that it would roll out a plan that would see the introduction of tax incentives on electric vehicles. Subsidies on cars were pegged at 150,000 rupees while that of two-wheelers would stand at 50,000 rupees. Their target is to hit close to 7 million units being driven on Indian roads by the year 2020.

In New Delhi, India there is an exemption of VAT of up to 12.5% and a refund on road tax and registration charges up to 2%. On the other hand, despite the fact that, China offers a huge tax relief (120 000Yuan) as compared to other countries, the gross sales of electric vehicles stands at only 8,159 electric vehicles which are much lower than other nations. This figure was realized in large part due to the production of unsubsidized lead-acid EVs. The production of these lead-acid EV's takes place without approval from the central governments with more 25,000 units being rolled out every year. This

EV's produced in Shandong has a top speed of less than 50 km/h hence a driving license is not required to operate it.

With a price tag of 31,600 Yuan, they are way cheaper than hybrid vehicles hurting sales of plug-in vehicles sharply. The Lead-acid EV's have come under heavy criticism by most major automakers. The September announcement 2013, the National Development along with Reform Commission, the industry and finance ministries, it states that a $9,800 maximum on an all-electric passenger car along with $81,600 on electric buses would get introduced. The government vowed to facilitate the tax credits.

The introduction of such incentives by the government saw the number of electric vehicles rise to 31,137 units. This was a 328% increase during the same period in 2013. The Indian government introduced a relief of 950 million rupees on all electric vehicles in the country. It was a 20% advantage on the price of retail on electric vehicles with a highest benefit of 100 000 rupees on electric cars, 60 000 rupees on three wheelers, and 400 000 rupees on electric mini-buses. The government of Japan also introduced tax reliefs on the purchase of hybrid, electric vehicles, and natural gas. The guideline gave a relief of about 50% the increased costs of new energy vehicles more than to the common engine cars of internal combustion. The program which was introduced in 1996 and amended in 1998 was eventually extended to 2013.

Ontario, Canada began the execution of their *Climate Change Strategy* showing their focus to the greenhouse gas emissions minimization in the Province. This strategy aims at reducing emissions in the transport industry by encouraging the uptake of electric vehicles. If the success of the fight against climate change is to be realized, a shift to the use of zero or low emission vehicles is very important. The Electric Vehicle Incentive Program (EVIP) was put in place in the year 2010, and its main aim was to reward early customers and develop a market for the new technology. The EVIP was revised to make EVs cheaper to purchase, to cap incentive amounts for expensive vehicles and also to provide more relief to cars with large batteries. The revision of EVIP took effect on February 10, 2016. The objective of the revision is to maximize the rate of electric vehicles adoption and plays a great responsibility in minimizing the greenhouse gas emissions.

Japanese lawmakers passed the "*Green Vehicle Purchasing Promotion Measure*" in May 2009. It provided tax relief on the purchase of electric vehicles and fuel efficient cars. This applied to both domestic and internationally produced cars. It gives relief on the purchase of two cases: customers purchasing new private car without having a replacement program along with customers trading a second-hand car registered about 13 years ago for a new car. Hybrid electric vehicles along with plug-in hybrids are exempt from taxes. Customers purchasing a new electric vehicle will profit from a 50% minimiza-

tion of the annual automobile tax. The reliefs that applied once took effect starting from April 1, 2009, and ended March 31, 2010.

Purchasing electric vehicles incentives without a used vehicle begins at 100,000 Yen for a small vehicle and 50,000 Yen for mini-trucks. For trucks along with buses with the stated emission levels and fuel efficiency is between 200,000 Yen and 900,000 Yen. The entire reliefs on new purchases with or without trading used vehicles got applicable from April 1, 2009, to March 31, 2009. The South Korea Trade Ministry, Industry, and Energy suggested a plan of developing charging stations across the nation, make batteries in electric vehicles run longer as well as make purchase prices cheap and affordable to the customers. By this, the South Korean government hopes that it will drive the market share for electric vehicles upwards from 0.2 in 2015 to 0.5% in 2017. They further project to achieve a 5.3% in 2020.

Among the South Korean government's goals was to develop an electric car battery by the beginning of 2016 with a high energy density that doubles the travel range on one charge to 400km. The market share for South Korea's electric cars is expected to be at par their regular internal combustion engine cars which reached 8.5%.

In Europe, there are measurement that promotes electric vehicles in the European Parliament's Directive2009/33/EC along with the Council of 23 April 2009 on clean and energy-efficient promotion of road transport vehicles. By 2011 April, there were 15 of

the 27 European Union member states, provided tax incentives for plug-in vehicles. This comprised all Western European nations including the Czech Republic and Romania.

Advantages of Electric Vehicles

There are several advantages and associated with the EVs, for instance, they reduce air pollution and emission of harmful fumes to the environment. The internal combustion engine produces direct emissions through the tailpipe, including smog-forming pollutants like nitrogen oxides and greenhouse gasses (GHGs) specifically carbon dioxide.

By contrast, EVs produce no tailpipe emissions improving local air quality. Plug-in hybrid electric vehicles (PHEVs) generate evaporative emissions while operating on gasoline or electricity. Therefore, EVs are more efficient and environmentally friendly as compared to the conventional cars that rely entirely on gas. Gas cars produce close to half of the gross atmospheric pollution with the principal air toxins like carbon monoxide and hydrocarbons, and this has led to global warming (Van et al., 2300). Therefore, switching to EVs will be a way of controlling global warming.

The energy used to power EVs can be harnessed from renewable energy sources, like geothermal, wind and solar, allowing even further reductions in emissions. Even though electricity can be produced from sources like coal, EVs can still improve local

air quality be eliminating tailpipe emissions in congested cities. Also, EVs steer a trend towards the utilizing of eco-friendly materials, for instance, Ford Focus is made out of recycled materials and bio-based materials. Also, Nissan Leaf's body and interior are partially made out of green materials like recycled plastic bags and water bottles, old car parts and second-hand home appliances and their batteries are fully recyclable.

EVs run entirely on electricity meaning a person does not need to buy gas ever again. The average American spends around $2,000 to $4,000 each year on gasoline. Though, electricity may not be free it is way far much cheaper as compared to the conventional cars since gas prices are highly unpredictable and they have hit high peaks in the past decade.

The cost per mile to fuel an electric car is around a quarter the cost of an ICE car based on the cost per mile. Beyond the fuel saving benefit, EVs offer other commendable cost savings. For example, an EV is fully electric, and one does not need to lubricate the engine among other costs because it only requires the owner to rotate the tires and keep them inflated with the right amount of pressure.

Charging stations for EVs can be installed at home and are available in parking lots and other public places thus, saves people the hustle of checking into gas stations for refilling because with EVs one can recharge their car at their convenience. Particularly, many nations and states dish out remarkable incentives to people who invest in eco-friendly

alternatives like using EVs. Conventional cars rely only on fossil fuels for propulsion, but PHEVs depend on both electricity and fossil fuels. Therefore, in case one of the power plants does not have sufficient supply the car can rely on the alternative.

The EVs popularity and the industry of are growing fast and they are putting forward a variety of cars for consumers to choose from since they are unique and user-friendly. Moreover, EVs undergo the same fitness, safety and testing procedures just like other vehicles. Therefore, in the case of an accident the airbags open up and electricity supply from the battery cuts to protect the passengers from injuries.

The fact that EVs travel at lower speeds as compared to the gasoline cars makes them far much safer because many fatal accidents occur when cars are moving at high speeds as compared to cars traveling low speeds. Therefore, even if an electric vehicle incurs an accident, there are only slim chances of fatality. Recent research illustrates that EVs have a higher center of gravity when compared to the traditional ICE cars and thus, they cannot roll over when an accident takes place.

Also, governments tend to give huge tax breaks and credits to people who use EVs. For instance, Nissan Leaf goes for about $30,000, but with the tax breaks, one can secure with $20,000 because the leasing company takes up the tax break and credits the savings to the purchaser. EVs are considerably quieter than a conventional car and the mo-

tors that are installed in their drives give the user a smooth ride. As a result, this serves as an initiative to prevent environmental degradation and mitigate noise pollution.

The use of EVs ensures that the US reduces its over-reliance on petroleum imports hence, creates security and assurance for sustenance in the energy sector and reduces the amount of money the nation uses to import crude oil products. Thus it makes sure that there is trade balance between the U.S. and the Middle East countries and because the imports will reduce, and cost savings to individuals. Moreover, it means if the usage of petroleum products in the entire nation reduces then oil refineries will be less functional, and this serves to reduce water pollution. Oil spills are the leading cause of water pollution in the entire world, and this pollution poses a threat to the marine life.

Challenges with Electric Vehicles

Environmentally, people think that EVs will have no negative impact, although environmentalists think otherwise because the increase in EVs will call for greater electricity production from thermal and nuclear power plants and this will affect the environment adversely. Moreover, EVs have not yet become very common, so not many people have them hence, the charging stations are limited, and this fact discourages a lot of individuals from purchasing EVs.

An EV can take longer period to move from one area to another compared to the counterparts of their ICE. Mainly, they can only top out at around 55 miles per hour while gasoline cars have can go up to 135 miles per hour. Besides, a typical EV has an average range of 75 miles before its battery dies, but gasoline cars have an excellent range. Therefore, it means that EVs are highly incapacitated to travel long distances which can be highly inconveniencing.

The technology of making EVs is relatively new in the market, and so the EVs are very expensive since every component of the vehicle is costly. Also, fixing or replacing anything in the vehicle is expensive as compared to gasoline cars because their parts are uncommon in the mainstream market. EVs cannot cruise, speed up or climb fast enough to beat the gasoline cars and accessories like air conditioners, video players or radios that drain the battery very quickly. People view EVs as weak because, unlike ICE cars, EVs do not have towing capabilities.

Filling a tank of a gasoline car takes just a few minutes at the gas station, and then one is ready to hit the road again. On the other hand, EVs may take up to 8 hours to be fully charged and there is no quick stop refilling so, the user has to technically plan for everything which proves very inconvenient because one cannot respond to an emergency. Also, they are not suited for countries or cities that face electricity shortage because EVs certainly need the power to start. Although, even for cities with steady power sup-

ply, the increase in EVs will strain its daily power production because it will need to produce more power to meet all the needs of its residents.

EVs can increase an owner's energy bill if they did not consider their options wisely. For people who want to just buy an electric car without doing thorough research and weighing their options, then it is possible they intend to make an unwise and uninformed decision. Occasionally, electric cars need a huge amount of charge for its propulsion and may reflect on one's bill every single month because electricity is not free.

Additionally, depending on the type and how frequently the battery is used, it may require replacement after every 3-10 years and they cost a huge amount of money which may not be available to everybody. Notably, the majority of EVs that are available today are tiny and can only accommodate two people at most. Therefore, are unsuitable for a person with a family because even the presence of a third would make the journey extremely tedious. An EV is silent and does make any noise; it is disadvantageous for people who are of hearing sound coming from behind them. For that reason, EVs can lead to increased accident incidents.

The Good and the Bad: Ideas Tied To Electric Vehicles

EVs hold a considerable measure of guarantee for a stable situation for the environment. As the impacts of global warming turn out to be even more a worry to individuals, the utilization of these autos could prove to be more helpful in the years ahead. For instance; firstly, electric automobiles emit minimal GHGs. Despite the fact that the autos can bring about natural harm while getting power from coal power plants, electric vehicles would significantly diminish the measure of GHGs when controlled by plants that don't emit greenhouse gasses. Notwithstanding when created from coal-smoldering plants, EVs reduce carbon dioxide emissions by as much as 22 percent as compared to ICE cars.

Secondly, albeit electric autos still have an issue with requiring a steady supply of electricity, PHEVs combine the usage of a standard motor with battery control. At the point when PHEV's battery runs low, the motor gives it an additional help. The hybrid EV offer the likelihood of utilizing energy from an ordinary electric network, thus preventing the usage of coal even later on. Thirdly, increased usage of electric cars would mitigate the measure of smog-forming pollutants that are produced by gasoline cars by as much as 32 to 99 percent.

As analysts search for more option approaches to replace ICE vehicles that can harm the environment, electric autos give a cleaner type of energy when power originates from a cleaner electric framework. The environment will profit by the developing uti-

lization of EVs as dynamic changes are made for the renewable power sector. Electric cars have ecological points of interest as compared to the gas and diesel-controlled cars in different perspectives, for example, ozone depletion, utilization of water, steel and copper materials. Despite the fact that the autos still experience few drawbacks until upgrades or the changes made, EVs might be a factor on global warming.

The majority of the people that use EVs tend to have the perception that using EVs that obtain their energy from coal-fired plants are helping to better the environment. Although, a series of recent studies show that, this may not always be the case because EVs have the capability of polluting the environment more than it was.

Apparently, it is hard to outweigh gasoline because many technologies that people are better and eco-friendly as compared to gasoline, they are not. The primary concern is the source of the electricity for the EVs, a good percentage of the energy is harnessed from coal. Therefore, electric cars yield 3.6 more soot and smog death as compared to gasoline because of the pollution that occurs during the generation of electricity. Moreover, EVs are good heat trappers of carbon dioxide which even worsens the global warming phenomenon (Van et al. 2309)

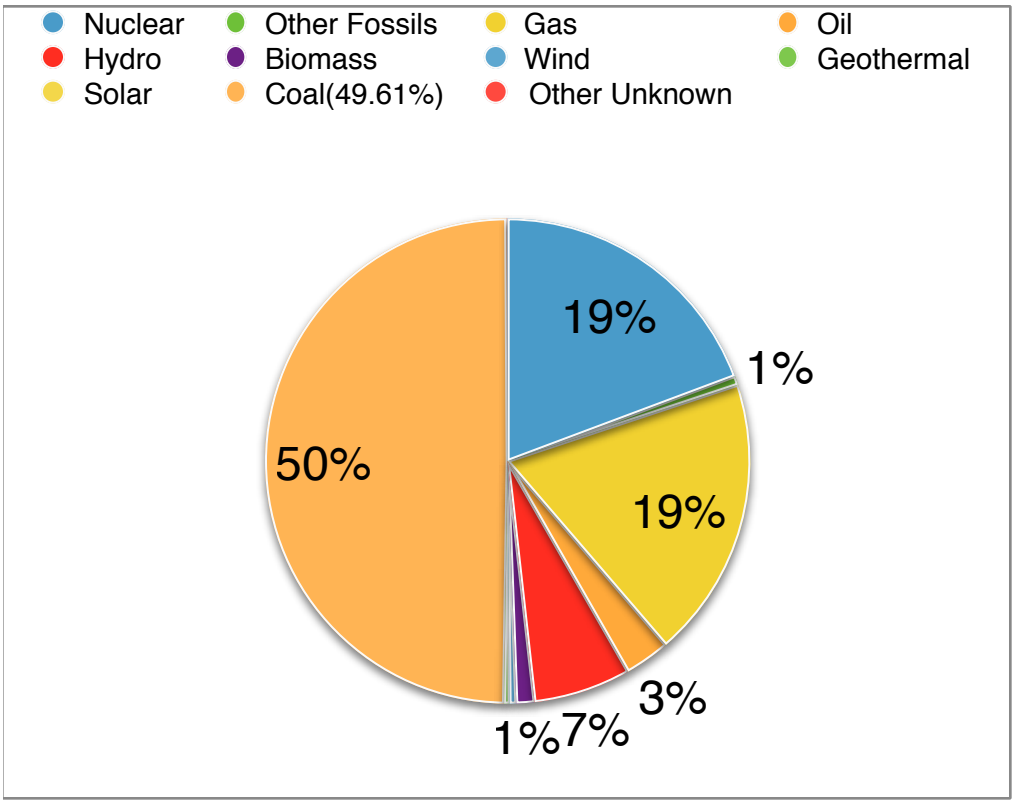
EVs lead to 86% more deaths from air pollution as compared to gasoline powered cars. Although, if the power comes from natural gas then the EVs produces half as many air pollution-related health complications as compared to the gasoline cars. Likewise, if the

electricity comes from a renewable source of energy like water, solar, wind or wave energy, then it accounts for just a quarter of the air pollution deaths.

The Source of Electricity for Electric Cars

In their capacity as human beings, there are several things that people can do to encourage the electric vehicles sector. Although, the only change that people to effect changes their mindsets, support technology, and research intensively so that they can know the truth about EVs.

Ultimately, people to be aware of the origin of the power they use. Categorically, there are two large sources of electricity namely renewable and non-renewable sources. Below is a pie chart showing the respective sources of electricity globally in 2014:



Retrieved from Aydin 68

It is unfortunate that a greater part of the electricity people use is mainly obtained fossil fuels like gasoline and coal. Fossil fuels are non-renewable and cause gross pollution to the environment. On the other hand, renewable energy is eco-friendly and rarely pollutes the environment. Apart from polluting the environment, the reliance on fossil discourages the independence of the America's energy sector. Imports make America incur trade deficits that affect the economy negatively thus; people should mind the source of the electricity they use so as to grow the economy of the country together. People should insist on using energy from renewable sources so as to mitigate the effects of global warming and pollution.

Improving Policies, Technology, and Science in the EV Industry

There are several ways through which all stakeholders, consumers, government and the public can improve the technology and science of the EVs industry. Naturally, the car industry is highly dynamic, spontaneous and consumer-oriented. Hence, if people join

hands can steer the industry forward as well as conserving the environment. Improvement in technology calls for creativity, innovation, and resources especially financial.

The United States has made significant progress in fostering the development of technology and science in the industry respectively. So far there are policies that the federal government has put in place for the sake of boosting and ensuring development and quality in the EV industry. The government usually has the greatest control of EVs and to improve these policies; it needs to consider all factors that can lead to growth, sustenance and healthy competition in the industry.

Conclusion

Alternative fuel vehicles are gaining popularity in many areas of the world, and different governments are entirely ready to steer forward the technology while others have invested in it and it has borne fruits. Although, at some places the technology shows a gradual take up due to the shortage of infrastructure to keep the EV moving. Therefore, there are three issues that the industry needs to address promptly, and they include the battery technology, availability of EV charging stations and determine if the prices of electricity continue to skyrocket up to a point where gasoline will be the most economical option. This paper shows that U.S. and China have more similarities on Alternative fuel vehicles policies that expected, this could become the opportunities for these two counties to learn from each other. However, Trump's pick, Myron Ebell, who is a con-

trarian of the scientific consensus on global warming, on head the transition team at the EPA will still create concerns for the American people.

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