

ECON 347

The Acceleration of the Electric Automobile in the United States



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There are many improvements to be made in the energy efficiency of automobiles in the industry as a whole. Given that, the United States has much work to do especially if it wants to be a world leader in sustainable transportation innovation. We have seen a rapid improvement throughout the recent history of the mass produced electric car, starting with the General Motors EV1, to where we are now with the Tesla Model S. American society is slowly adopting electric cars. This paper will explore how and why this is the case.

There are a number of things that need to take place until we see a sustainable automobile industry in North America. We have a record amount of CO₂ in the atmosphere and the levels of CO₂ are growing exponentially (see figure 1.1). The last time we had this much carbon concentration was 11 million years ago.¹ Increased CO₂ leads to increased temperature; we have already increased the world's temperature by 2.3F. The extreme temperature changes are upwards of 20F.² Fifty-three thousand deaths are attributed to automobile emissions in the United States on an annual basis.³ Making the transition to sustainable transport is the first of many steps to tackle the problem of global warming and climate change.⁴

Currently, there is no electric automobile without a compromise, but with more research and technological advances the electric car could be the future of transportation. As idyllic as the Tesla lineup may be, it is prohibitively expensive for mass market consumption. On the other hand, there is the affordable Nissan Leaf, which is limited by range and charge time. Distance (range) is yet another problem with the current state of electric automobiles. Although the average commute of an American is only 18.8 miles,⁵ a distance all electric cars could handle, people still want a car unrestricted by range.

One would think that low oil prices would temper demand for electric vehicles. Despite the recent consumer interest for electric vehicles (as illustrated by Tesla's Model 3 initial reception) lower oil prices will generally inhibit adoption of non-fossil fuel solutions for transportation needs.

¹ <http://www.esrl.noaa.gov/gmd/ccgg/trends/>

² <https://www.climate.gov/>

³ <http://news.mit.edu/2013/study-air-pollution-causes-200000-early-deaths-each-year-in-the-us-0829>

⁴ <https://www.youtube.com/watch?v=Q4VGQPk2DI8>

⁵ https://www.census.gov/hhes/commuting/files/2012/Paper-Poster_Megacommuting%20in%20the%20US.pdf

Another growing concern with electric cars is the battery.⁶ Although electric cars are better for the environment than cars that use petroleum, electric cars are not perfect. The extraction and disposal of an electric car's battery is harmful to the environment. The extraction process of the rare earth minerals needed to produce lithium-ion batteries needs to be improved in order to make electric cars part of a sustainable future. Many governments subsidize the price of electric cars, though not as much as the Norwegian government. Although Norway's⁷ main industry is the extraction of petroleum and natural gas, Norway still manages to have the highest number of electric cars per capita.⁸ This is the case because Norway subsidizes many aspects of owning an electric car.

With more electric cars on the road, we need more ways to produce electricity that are less harmful to the environment. Society needs to harness the energy of the sun, water, and wind to provide sustainable recharging methods for automobiles. There is more than enough energy from the sun to power our cars using solar panel energy. Significantly, even if one were to charge his or her electric car with electricity created by a coal plant, it is still less harmful to the environment than using a gasoline-powered car.

Cars produce an enormous amount of carbon emissions that are later released into our atmosphere, leaving us vulnerable to things like pollution and greenhouse gasses. All cars, including electric cars, produce emissions; once electric cars are on the road they are "emission-less," although the production and extraction of the materials needed to create an electric car should not be left unmentioned.

There are 2 billion vehicles on the road worldwide. There are 100 million gasoline powered cars added each year, thus even if all new cars were electric it would take 20 years before gasoline cars are replaced. Electric cars make up less than one percent of auto sales in America.⁹ We are rapidly exhausting the carbon capacity of the oceans and atmosphere. Switching to the electric car completely would entail replacing trillions of dollars of

⁶ <http://www.cnbc.com/2014/12/16/all-electric-cars-not-so-eco-friendly.html>

⁷ <http://www.nytimes.com/2015/10/17/business/international/norway-is-global-model-for-encouraging-sales-of-electric-cars.html>

⁸ <http://www.cbc.ca/news/canada/british-columbia/norway-evs-bc-1.3292682>

⁹ <https://www.youtube.com/watch?v=hF45qsAwSvw>

infrastructure to replace the oil industry with the electric industry.¹⁰ Even if society adopted electric cars as fast as possible, the transition still would not happen that fast due to the sheer amount of changes necessary to become sustainably electric. As a society, we are not adequately rewarding talented individuals in the progression of a sustainable future, let alone that of an electric car, which is the first of many steps needed to be taken to get there.

We live in an economically driven world. The price of an electric car at first will be greater than that of an equivalent gas-powered car; however, running an electric car is more affordable. Where do prices converge on a mileage (usage) basis? That all depends. One thing to incentivize people to buy electric cars is government subsidies, which were put into place by the American government with the intention of people purchasing electric cars to be more environmentally conscious.

Electric vehicles have been available to Americans for the past twenty years. The first mass-produced electric car, the General Motors (GM) EV1 had a range of 70-100 miles, although there have been claims¹¹ that the electric car in fact only had a range of a mere 50 miles. The electric car did not succeed because around the time the EV1 was going to be in dealerships, California weakened its legal mandate, “relieving the legal pressure of automakers to offer zero-emission cars” according to Alex Davies of *Wired Magazine*. Even though GM thought they were making the wise decision to abandon the electric car, in the years that followed Toyota was immensely more successful due to its offering an affordable fuel-efficient car, the Prius (hybrid).

Today, electric cars can travel 320 miles on a single charge as is the case with the Tesla Model S.¹² The more affordable Nissan Leaf, however, can only travel 80 miles on a single charge. Many potential customers are deterred from the idea of an electric car due to “range anxiety.” A 2013 study by the California Centre for Sustainable Energy found that only 8 percent of consumers would be satisfied with an electric car that goes 100 miles; however, that number dramatically increases to 70 percent if they said they could go 200 miles on one charge.¹³ Why

¹⁰ <https://www.youtube.com/watch?v=Xva5-dYOv0U>

¹¹ <http://www.wired.com/2016/01/gm-electric-car-chevy-bolt-mary-barra/>

¹² https://www.teslamotors.com/en_CA/models?redirect=no

¹³ https://energycenter.org/sites/default/files/docs/nav/transportation/cvrp/survey-results/California_Plugin_Electric_Vehicle_Driver_Survey_Results-May_2013.pdf

not go for the Tesla Model S? Well, the Tesla comes at a premium price just short of \$70,000 (for the base model) which makes it unattainable for most Americans. Elon Musk, CEO of *Tesla Motors* has called 200 miles the “minimum threshold” for the public adoption of electric cars. The first car that gets to the 200-mile range with an affordable price will be widely successful. Will it be the Tesla Model 3? Yes, in fact the Tesla Model 3 has a range of 215 miles according to Tesla’s Model 3 launch last week.¹⁴

Lithium-ion batteries are relatively new. The chemistry behind them is roughly ten years old. The battery is what makes electric cars so great, but batteries can be quite difficult to create. Batteries are sensitive to temperature, they can be overcharged, they can catch fire and lastly, they are expensive. If the electric car is to move forward, the battery needs to get cheaper. McKinsey Consulting believes that the price of batteries could be cut in half by 2020.¹⁵ Deutsche Bank believes that car batteries will decline in price the same way laptop batteries declined in price. The problem with respect to lithium-ion batteries will be somewhat solved for Tesla with the completion of their Gigafactory in Nevada.¹⁶

Batteries are also a much more efficient use of energy than gasoline engines because the energy stored in gasoline engines is lost during the heating process, which does not happen with batteries. EVs emit no pollutants once they get on the road although during the recharging of the battery they do need energy and, when you plug-in, depending on your power source, one could emit emissions (from the use of materials to create the energy such as coal, nuclear, etc.). An electric vehicle being charged with coal power is still far more efficient than a gasoline powered vehicle. There are also alternatives to getting an emission-less electric car on the road; electric cars could get their energy from solar, wind and/or hydro plants (renewable energy). Elon Musk famously said that “only a space of 100 miles by 100 miles filled with solar panels will generate enough electricity for the whole US.” This could happen in a little area of Nevada or Arizona. It is possible to go green, but are people ready to spend the money on the infrastructure in order to do it?

¹⁴ <https://www.teslamotors.com/model3>

¹⁵ <https://www.washingtonpost.com/news/wonk/>

¹⁶ <https://www.youtube.com/watch?v=BQ7hjSD4KCY>

Prices for electric cars are slowly decreasing, in large part due to governmental incentives. The price of running an EV is much lower than that of a petrol car; you don't have to pay for gas, oil changes and often insurance rates are lower. In the United States, there are 20,000 electric car charging stations.¹⁷ They are increasing at an accelerated rate. In 2011, for example, there were less than 2,000 charging stations. If the United States adopted an Open Charge Point Protocol (OCPP) like that found in the Netherlands, innovation could increase and be more economically beneficial in the long term.

Another beneficial aspect of going green in the automobile industry is America's energy independence. America imports \$300 billion of oil each year, which represents two-thirds of their trade deficit.¹⁸ The rise of the electric car would bring more jobs back to America and allow it to become more independent again, or as some would say "Make America Great Again." President Obama, in his annual State of the Union address, said, "My message to business leaders is simple: ask yourselves what you can do to bring jobs back to this country, and your country will do everything we can to help you succeed."¹⁹ The popularity of the electric car is bringing jobs back to America, which is arguably why the government is so involved, less so because of their concern for climate change.

Greenhouse gas levels are at an all-time high. Just this past month (February) was the hottest month ever recorded.²⁰ Greenhouse gas emissions are not something to be neglected, yet politicians dislike talking about them because it is bad for business. The Golden State (California) has historically been the worst for car emissions; however, now it is setting the example. In Palo Alto, 7 out of every 1000 cars are electric.²¹ California also has an aggressive emissions reduction mandate, which is forcing the state to go green. Navigant Research estimates that there are 200,000 pure electric cars among the total of 242 million cars in America.²² Most of these EVs were bought with state and federal tax incentives. Much of the cost of electric

¹⁷ <http://www.techrepublic.com/article/the-state-of-electric-cars-10-things-you-should-know/>

¹⁸ <http://www.cheatsheet.com/automobiles/7-reasons-electric-vehicle-adoption-is-inevitable-in-america.html/?a=viewall>

¹⁹ <https://www.whitehouse.gov/the-press-office/2012/01/24/remarks-president-state-union-address>

²⁰ <http://www.cnn.com/2016/03/17/weather/february-warmest-ever-month/index.html>

²¹ http://www.cityofpaloalto.org/gov/depts/utl/residents/sustainablehome/electric_vehicles/default.asp

²² <http://www.cnn.com/2014/08/18/electric-vehicles-a-point-of-debate-for-2039.html>

vehicle now is not in the cars themselves but the research needed to create a mass-market efficient electric vehicle. The United States has made a large investment in electric vehicle infrastructure by subsidizing the construction of charging stations. These investments may still not be enough for a sustainable future. The MIT Sloan School of Management estimates electric vehicle sales could reach just 3.7 percent of all vehicles sold in 2040 in the auto industry given current levels of investment. These same figure jumps to 50 percent if there is a substantial effort on the part of the auto industry, state and federal governments to encourage the use of EVs.²³

The Union of Concerned Scientists (UCS) USA found that electric cars generate half the emissions of the comparable gasoline car, even when pollution from battery manufacturing is accounted for.²⁴ Each car has three levels in its life: manufacturing, operation, and termination. Electric cars produce more emissions coming off the assembly line. Although, after a few months on the road, the electric car makes up for that, and then surpasses gasoline cars in the number of emissions abated.

Many critics of the electric car believe EVs will experience the “sizzle and fizzle” effect. This is when there’s initial enthusiasm for a technology but this enthusiasm does not last for prolonged periods of time. This enthusiasm wouldn't “fizzle” if there were a battery that would allow cars to travel further distances for less of a cost. Currently, electric cars are limited by range although plugin hybrids seem to be another story. The Chevy Volt, for example, offers 38 miles from the electric engine at which point the petrol engine kicks in giving it an additional 342 miles surpassing any electric car to date.²⁵

One thing that may bring the price of electric cars down is the introduction of Tesla’s Gigafactory. This factory will ramp up the production of lithium-ion battery cells, and it will create more lithium-ion batteries than every other plant combined.²⁶ Musk, CEO of Tesla, wants to encourage the development of a sustainable future, and one of the things that this entails is Tesla releasing all of its patents in the hopes of spurring rapid development of electric vehicle. Tesla’s goal is “to catalyze the development of a mass market for electric vehicles and to do so as

²³ https://mitei.mit.edu/system/files/On+the+Road+in+2035_MIT_July+2008.pdf

²⁴ <http://www.ucsusa.org/clean-vehicles/electric-vehicles/life-cycle-ev-emissions#.VuuIyxIrKR8>

²⁵ <http://www.cnn.com/2014/08/18/electric-vehicles-a-point-of-debate-for-2039.html>

²⁶ <https://www.youtube.com/watch?v=ZHeR2-ibg4>

rapidly as possible.”²⁷ One thing that may inhibit the future of the electric vehicle is that in 25 years gas-powered cars may be much more efficient, thus disincentivizing people to make the switch. The Union of Concerned Scientists estimates that the US could cut its oil consumption by 2 million barrels a day by 2035 if it stays on track with current levels of innovation, this doubles fuel economy standards by 2025.²⁸

One of the main concerns is that people simply do not want an EV because it is new and different. It is important to establish EVs as the cool, hip “norm.” Switching to a society of electric cars would mean shifts in entire industries. The jobs created by the mass consumption of EVs would far outweigh those of petroleum cars. This is due to the extensive infrastructure that needs to be created to facilitate electric cars. If the United States is first to create a successful electric car, they will see a massive demand for these cars in nations where oil is much more expensive.²⁹ China is the largest auto market and the world’s largest carbon emitter. If China is serious about reducing emissions, the economies of scale will play a role, and if anything, there will be a surplus in demand for EVs. This would make the US a large exporter to China, boosting the American economy.

In the spring of 2014, auto sales of the plug-in electric car had doubled from the previous year to a staggering 211,097.³⁰ John Gartner of Navigant Research estimated that 3.5 million electric vehicles would be on the road by 2023; this is an exceptionally high growth rate. There is not a large enough push by dealerships to sell their inventory of electric cars. The *Consumer Reports* found that car salesmen are more incentivized to sell gasoline powered cars for two reasons. First, electric cars are new and complex, and thus, take more time to sell. Second, sales commissions are often higher on gasoline powered vehicles than electric vehicles.

Eric Everts of Consumer Reports, who organized a survey, found that “only 19 percent of the dealers visited could give even a ballpark estimate of what it cost to charge a car.”³¹ The problem is that people want to save money, and according to the CBC, people are not buying as

²⁷ <https://www.teslamotors.com/blog/promise-electric-vehicles>

²⁸ <http://www.ucsusa.org/clean-vehicles/electric-vehicles/life-cycle-ev-emissions#>

²⁹ <https://www.youtube.com/watch?v=hF45qsAwSvw>

³⁰ Fialka, John J. *Car Wars: The Rise, the Fall, and the Resurgence of the Electric Car*. New York City: Thomas Dunne. An Imprint of St. Martin's, 2015. Print.

³¹ <http://www.consumerreports.org/cro/news/2013/12/electric-car-survey/index.htm>

many electric cars due to a lack of financial incentives with falling gas prices.³² The question then becomes can you make an EV so appealing that someone will buy it regardless of the price of gasoline?

Due to their favouritism of the internal combustion engine, Musk refuses to sell Teslas through dealers. Dealers like petrol cars because they have more financial incentives. Musk suggests that “they make most of their profit from service, but electric cars require much less service than gasoline cars.”³³ This is because electric cars require no oil, no spark plugs, or filter changes, no tune-ups, and no smog checks. Musk continued by stating that “overcharging people for unneeded servicing (often not even fixing the original problem) is rampant within the [auto] industry.”³⁴ Oil change scams are not uncommon and are depicted in a CBC special report.³⁵

Electric cars strongly encourage people to install solar panels on their home. This is because once you install the infrastructure to charge your electric car at home, you may as well include a solar panel to charge your car. There are also a number of financial incentives from the government for Americans to install solar panels. For these reasons, BMW has partnered with Solar City so when a client purchases a BMW “i” product (BMW’s electric-line), they have the option to install solar panels (for solar-generated electricity) while installing the electric infrastructure needed for an electric car.

The problem with the inclusion of home infrastructure is that each sale of an EV is different for each person. This phenomena is described by Alex Tiller, a product developer for Fidelity Investments working with electric car dealers in Hawaii. Hawaii has ideal conditions for electric cars; it is warm (so the batteries will last longer) and there is a great amount of sunlight so there is an abundance of solar energy for electricity. For these reasons, EVs have seen exceptional growth in Hawaii. Critics of the electric car love to point their fingers at Obama. President Barrack Obama emphasized the importance of the electric car in his campaign goals of 2011 at the State of the Union speech.³⁶ During this speech, he stated that there will be one

³² <http://www.cbc.ca/news/canada/montreal/montreal-auto-show-electric-cars-1.3404616>

³³ https://www.teslamotors.com/en_CA/blog/people-new-jersey

³⁴ https://www.teslamotors.com/en_CA/blog/people-new-jersey

³⁵ <https://www.youtube.com/watch?v=-avpx8UTakI>

³⁶ <http://time.com/money/3677021/obama-electric-cars-gas/>

million electric cars on the highways by 2015. This target was hit in September of 2015.³⁷ The majority of EV owners are usually college-educated, homeowners, and have good credit rating. These people already know that electricity is less than gasoline. The question is “by how much?”

Norman Hajjar, director at PlugInsights, found that in a survey of electric car owners whose leases are on the cusp of expiring or are selling their EV found that 96 percent of them plan to buy/lease a new electric car. This is an extremely high customer satisfaction rate. Hajjar found that the satisfaction rate for the Model S is between 94-99 percent, the Volt between 79-85 percent, and the Leaf between 49.8-66.8 percent.³⁸ Although the Leaf may seem to have a low satisfaction rating, it is still a good rating compared to most vehicles such as the highly rated Toyota Prius.

We are in an exciting time because now we have over 100,000 used cars on the market. This opens an entirely new segment to the market of the electric car (pre-release of the Tesla Model 3). One thing that could get the used car market buyers excited is the prospect of warrant-covered battery replacements. This is the case because a replacement battery could cost anywhere from \$10,000 to \$40,000.³⁹

There is a break down in the market system in respect to carbon created products. This disequilibrium is caused because of the lack of information in respect to the price of carbon, which makes oil based products more profitable than they should be. Musk argued that this disequilibrium is similar to that of international fisheries in that no one owns international fishing areas, so they will get “fished to extinction because there is no price for that, and there is no price for carbon so we do all these things that cause long-term damage” (with respect to climate change).⁴⁰

The rise in oil prices reduces the power of economic forces of cars to go electric. This is especially the case if oil is at decadal lows. Seeing that we live in an economically driven

³⁷ <http://cleantechnica.com/2015/08/08/1-million-electric-cars-will-be-on-the-road-in-september/>

³⁸ http://www.pevcollaborative.org/sites/all/themes/pev/files/Hajjar_Recargo2_California%20PEVC%20PlugInsights%20Presentation.pdf

³⁹ Fialka, John J. *Car Wars: The Rise, the Fall, and the Resurgence of the Electric Car*. New York City: Thomas Dunne. An Imprint of St. Martin's, 2015. Print.

⁴⁰ <https://www.youtube.com/watch?v=hF45qsAwSvw>

economy, it would make the most sense to make an electric car so compelling that people would buy it regardless of low oil prices. Will this be the Tesla Model 3? Unlike electric cars, electricity offers no differentiation which essentially makes it a commodity. This makes it harder to convince people to switch to solar energy to power their electric cars. To what degree are we willing to sacrifice the future for the present? Climate change deniers are a dying breed, since we all now know that humans have had some accountability in the creation of global warming (climate change).

At some point, we will have no choice and we will have to go to a solar electric future, although it would be better if we go green sooner rather than later for future generations.⁴¹ This is true now more so than ever because there is a growing urban population, and in order to have clean air in cities we have to go electric. “Time is important here. The sooner this can be done, the sooner we can reduce carbon output and reduce the probability of a catastrophe” says Elon Musk.⁴² There is definitely an argument to be made here. Most environmental and atmospheric scientists agree that with climate change we will have more powerful storms, more persistent droughts, rising oceans, and extremely warm and cold waves. It is commonly accepted that emissions from automobiles are among the most prominent cases of total carbon emissions. Musk alluded that his new Gigafactory would create more powerful, lighter and cheaper lithium-ion batteries and therefore the end of the internal combustion engine may be near. There is a counter argument by Stanford professors that maybe the electric car is not the solution. They have a non-emitting technology that can use electrolysis to split hydrogen from water, which can (now) be done in an affordable manner. Professor Hongjie Dai of Stanford stated that “this is the first time anyone has used non-precious metal catalysts to split water at a voltage that low. It is quite remarkable.”⁴³ This breakthrough could make fuel-cell cars the next big thing rather than electric battery-powered cars. The United States is the world leader in carbon dioxide pollution from urban transportation, producing a whopping 672 megatons of carbon dioxide emissions. Cars are the number one emitter of carbon dioxide, and climate change is endangering public health, burdening the economy (of the world), and lastly restricting our access to food. These

⁴¹ https://www.youtube.com/watch?v=SvW_RN9D_Hc

⁴² Fialka, John J. *Car Wars: The Rise, the Fall, and the Resurgence of the Electric Car*. New York City: Thomas Dunne. An Imprint of St. Martin's, 2015. Print.

⁴³ <http://news.stanford.edu/news/2014/august/splitter-clean-fuel-082014.html>

problems are not far away, Michael Replogle of University of California Davis says, “Transportation, driven by rapid growth in car use, has been the fastest-growing source of carbon dioxide in the world.”⁴⁴

One of Replogle’s studies has a “high shift” scenario called the Global Fuel Economy Initiative. It calls for the government regulators to require the use of fuel in cars to be cut by half, worldwide, by 2030. We may reach there even without the need of regulators, given our exponential growth in the efficiency of engines and the new electric-car technology. If these emission goals were met, the expected urban transportation’s carbon dioxide emissions would be 55 percent in comparison to what they may otherwise be in 2050. The question is: “How much of a mess do we want to leave future generations?”

In 2011, the first all battery powered electric vehicles reached American showrooms; now they are being seen on the streets regularly. Currently, only one-tenth of one percent of cars are electric and OPEC estimates that in the year 2040 electric cars will only make up for one percent of the world’s vehicles. The adaptation of new technology tends to have an S-Curve shaped demand, there are few earlier adopters of new technologies, however after some time a product goes into exponential growth, followed by a taper (representing an “S” shape). This was seen with the refrigerator, colour tv, computer, and cell phone.⁴⁵ If the S-Curve phenomena does transpire we can expect to see 50% of new cars in 2014 to have a plug.⁴⁶ We are about to take off with new transportation technologies as a society. Just last year we landed an intact orbital rocket on the surface of the planet after a successful space flight. If we could reuse rockets, space travel would get cheaper by a factor of 100. I believe that the electric car, the autonomous car (self-driving car), and the hyperloop (capsule in a vacuum) will all be coming out in the near future. This is a very exciting time in the history of transportation. We currently have the technology for the electric car, the autonomous car, and the hyperloop; however, they are yet to be produced for mass-market consumption. Personally, I predict that the timeline for the mass market electric car is 1 year. As of the time of writing this paper, Tesla has announced its Model 3, which will be offered at \$35,000, manufactured at a high volume for the mass market, and it will roll off the

<http://www.scientificamerican.com/article/cars-will-cook-the-planet-absent-shift-to-public-transportation/?print=true>

⁴⁵ http://www.encyclopedia.com/topic/S-shaped_growth_curve.aspx

⁴⁶ <https://www.youtube.com/watch?v=jwHN6QQWv2g&index=65&list=WL>

assembly line in early 2017. As of April 6th, 2016 Tesla has 276,000 preorders, far exceeding predictions, making it the most preordered car in history. Another prediction is that in 3 years time, we will see the autonomous car for human use in a limited environment. Finally, I believe that in 5 years we will see the first Hyperloop being built for travel between Los Angeles and San Francisco. From there on, who knows what we will see. These 3 advancements in transportation make traveling cheaper, faster, safer, and cleaner. In light of all these developments in transportation technologies, the singular largest impact on the environment will be the electric car.

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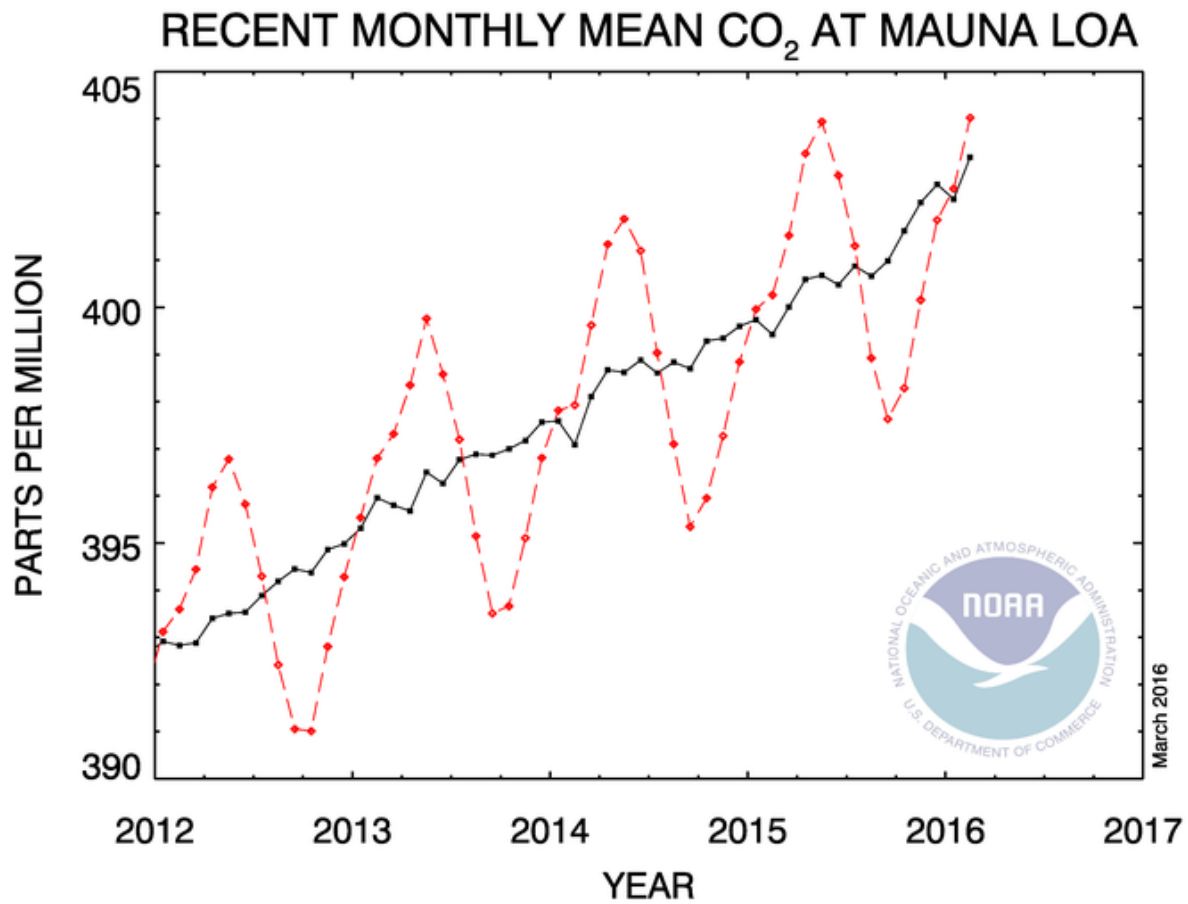
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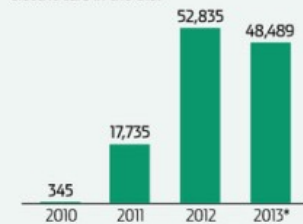
Figure 1.1

<http://www.esrl.noaa.gov/gmd/ccgg/trends/>



THE ELECTRIC MARKET

Sales of all-electric and plug-in hybrid electric cars in the U.S.



Total vehicle sales in the U.S., 2012: 14.5 million

*Through July

Source: Electric Drive Transportation Association

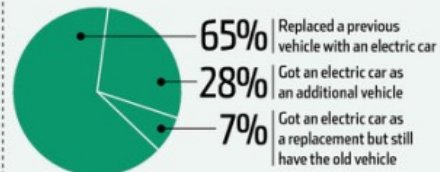
WHERE THEY ARE

Markets with the biggest share of U.S. registrations for new plug-in electric vehicles, January-May 2013



THEIR PLACE IN THE FLEET

Among households with Nissan Leafs, the percentage that:

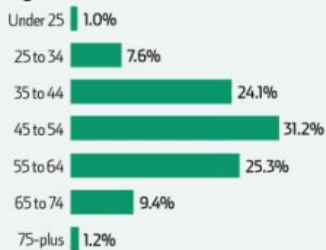


18% Of the vehicles replaced by the Nissan Leaf, the percentage that were vans, SUVs, or pickups

Source: University of California, Davis, analysis of data from various sources, 2011

WHO'S DRIVING | Demographics of participants in the EV Project (owners of Leafs and Volts)

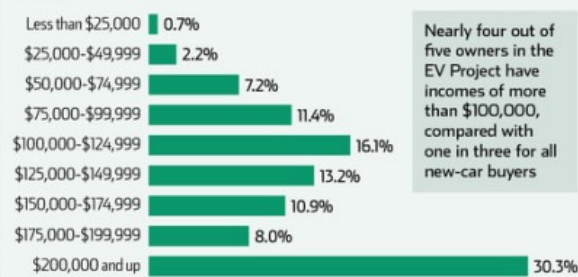
Age



Average age of all new-car buyers (2011): 51

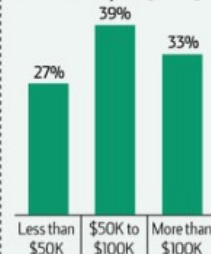
Sources: EV Project; Polk/IHS and Edmunds.com (income and age data for all new-car buyers)

Household Income

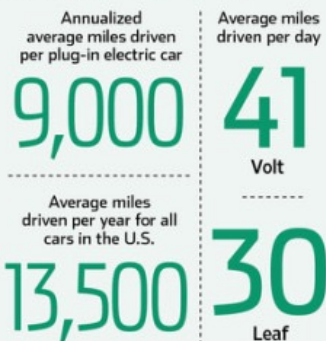


Nearly four out of five owners in the EV Project have incomes of more than \$100,000, compared with one in three for all new-car buyers

Household Income, all new-car buyers (2012)



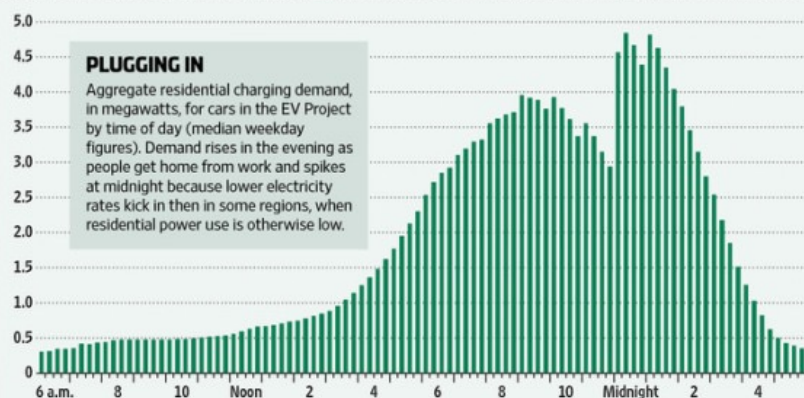
HOW THE CARS ARE USED



Sources: EV Project; U.S. Department of Transportation (miles driven for all cars)

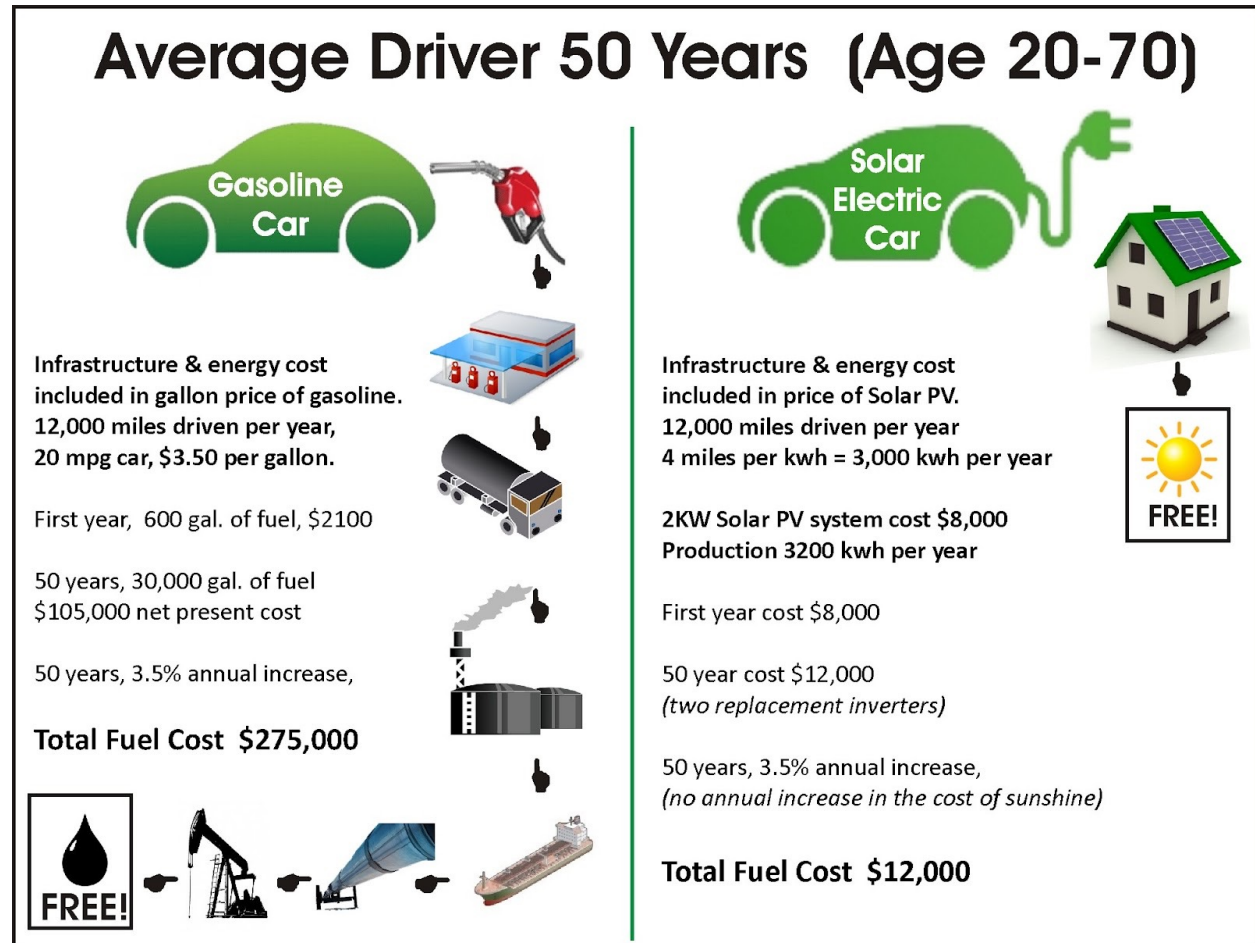
PLUGGING IN

Aggregate residential charging demand, in megawatts, for cars in the EV Project by time of day (median weekday figures). Demand rises in the evening as people get home from work and spikes at midnight because lower electricity rates kick in then in some regions, when residential power use is otherwise low.

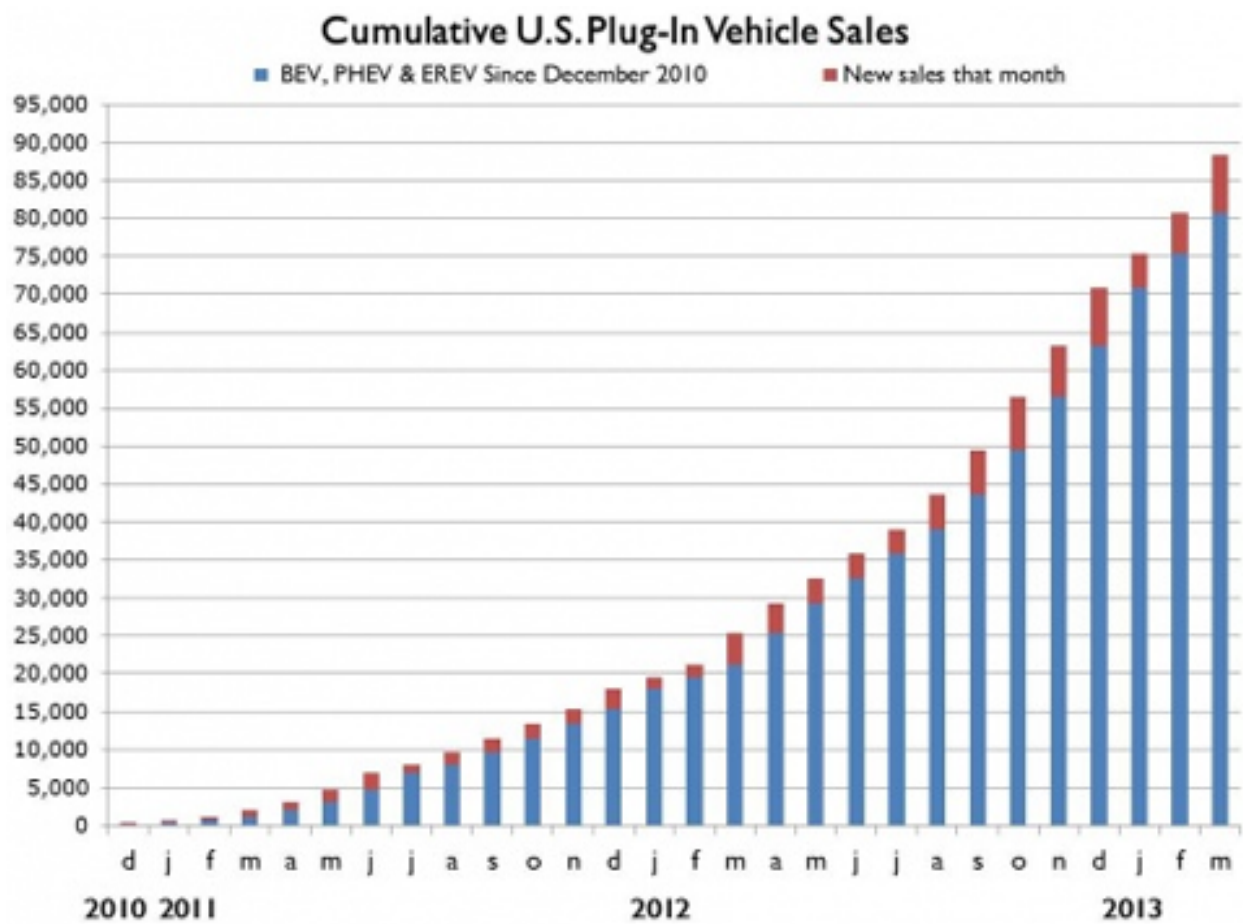


Source: EV Project

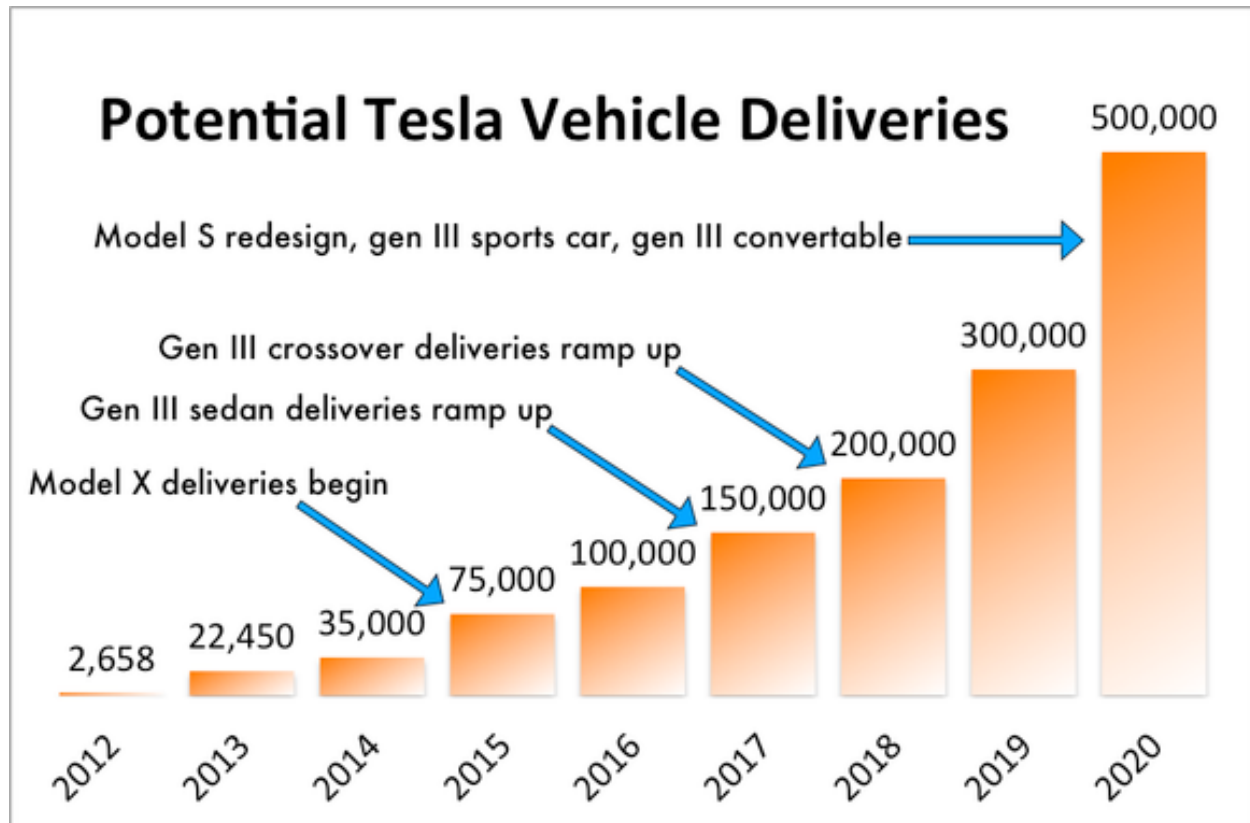
http://images.hgmsites.net/hug/gas-car-vs-solar-powered-electric-car-costs-50-years_100381539_h.jpg



http://3.bp.blogspot.com/-FXw6hjXW3bg/Ue_qH_yw2sI/AAAAAAAAAJ3s/pD29Z_LFRhk/s1600/Electric+Cars+Sales.png

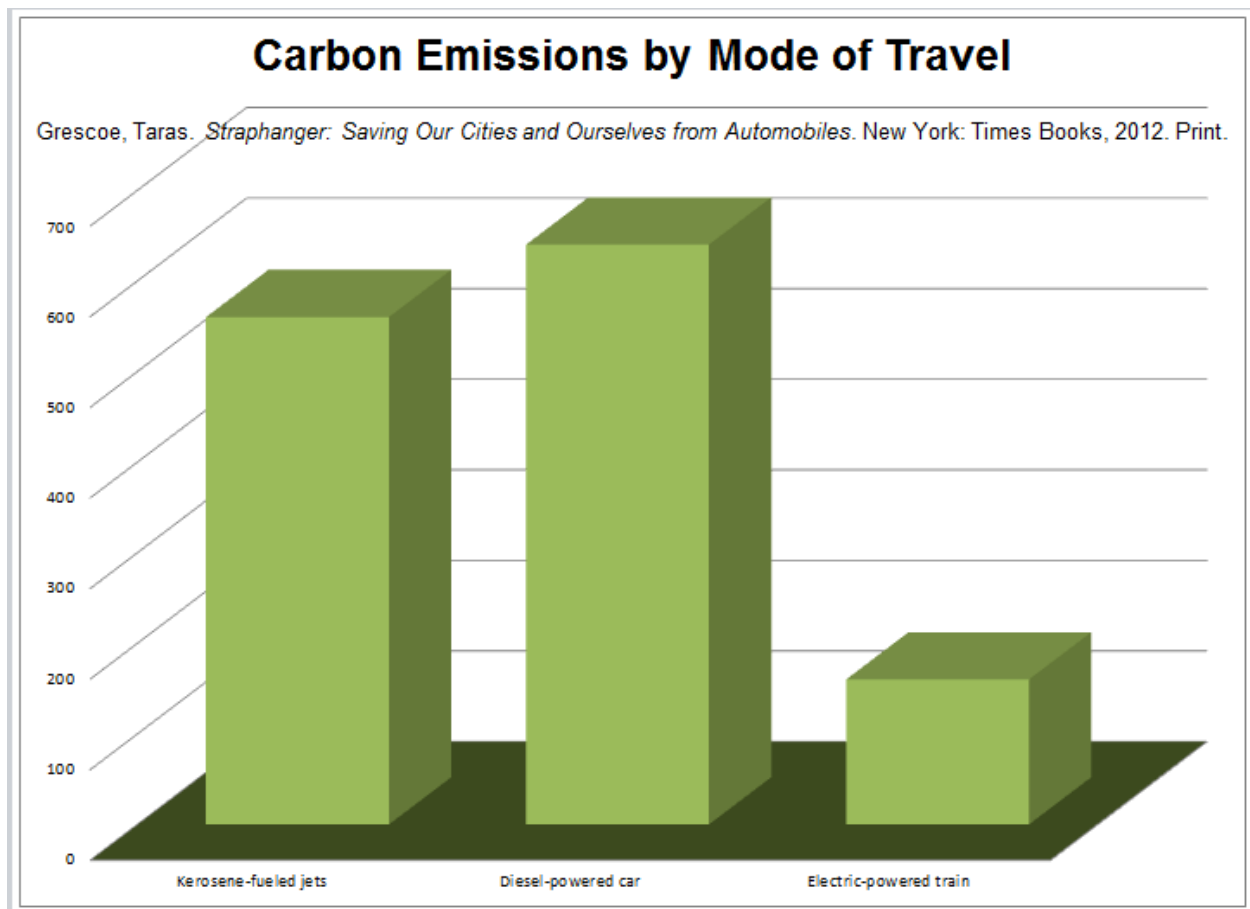


https://g.foolcdn.com/editorial/images/136669/tesla-potential-annual-sales_large.png

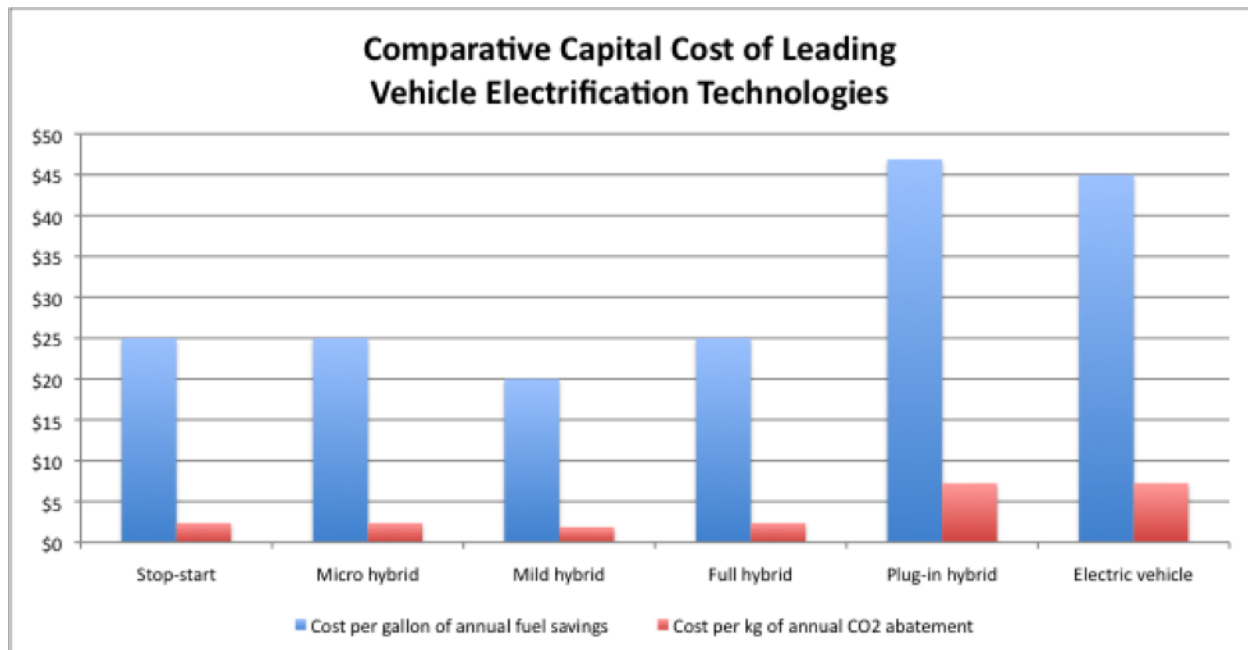


Note that as of April 6, 2016 there are 276,000 preorders for the Tesla Model 3. This making it the highest preordered car in history!

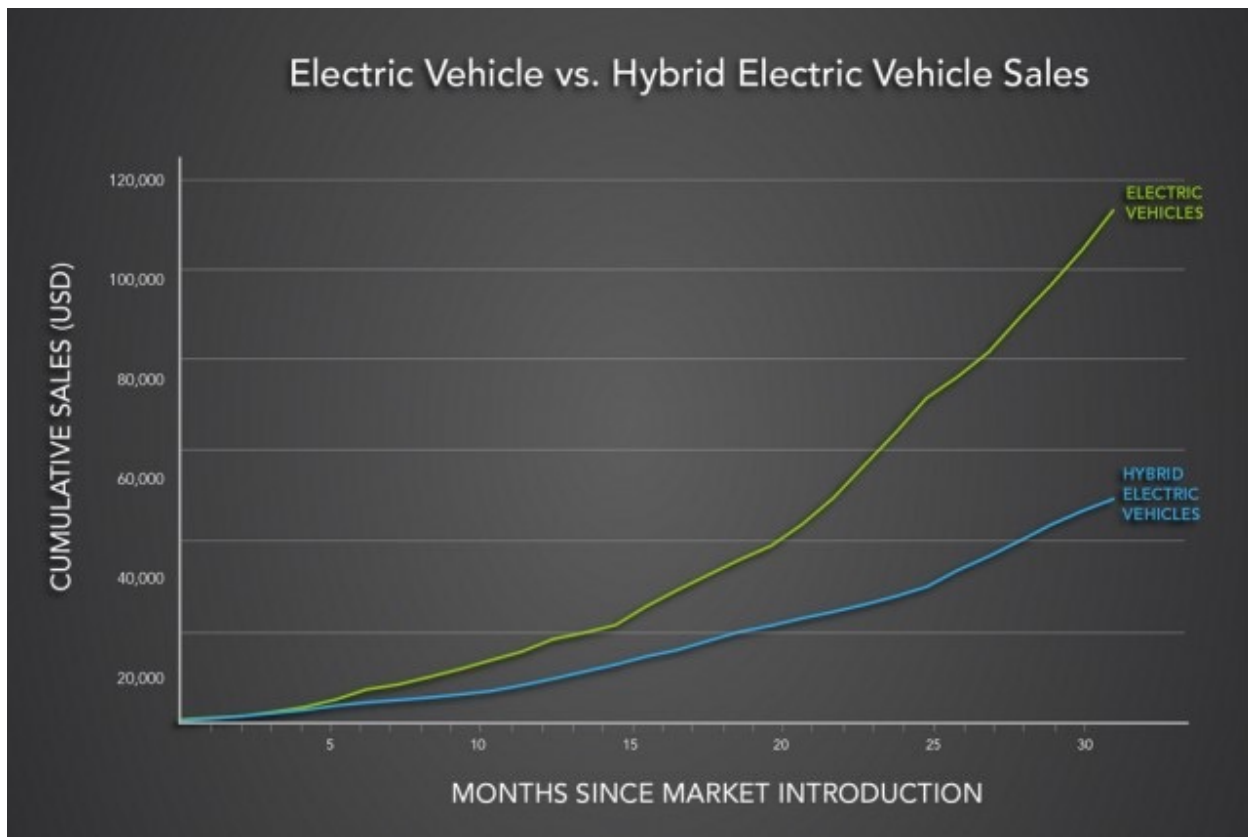
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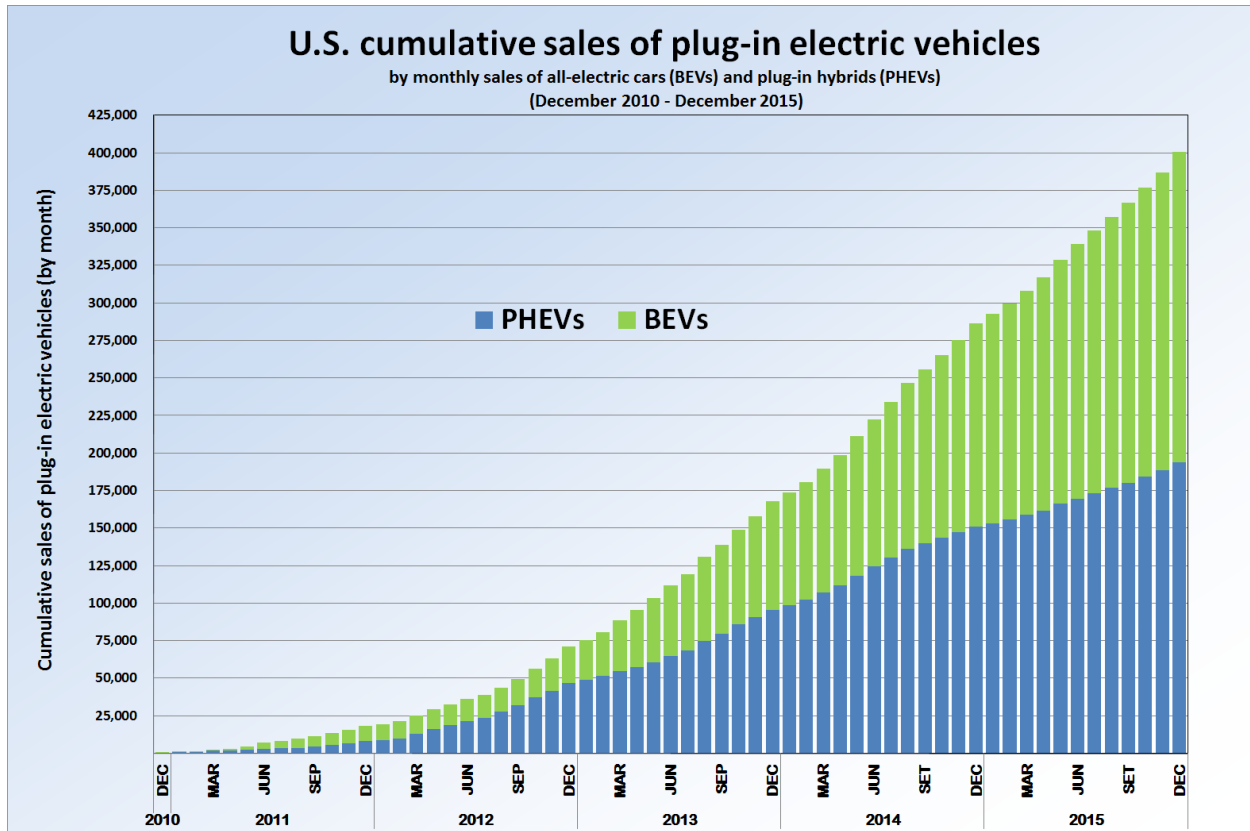
http://static.cdn-seekingalpha.com/uploads/2011/1/20/saupload_1.20.11_20cost_20graph.png



http://images.hgmsites.net/med/electric-vehicle-sales-vs-hybrid-electric-vehicle-sales-chart-issued-by-u-s-department-of-energy_100434362_m.jpg



https://upload.wikimedia.org/wikipedia/commons/7/7d/US_PEV_Sales.png

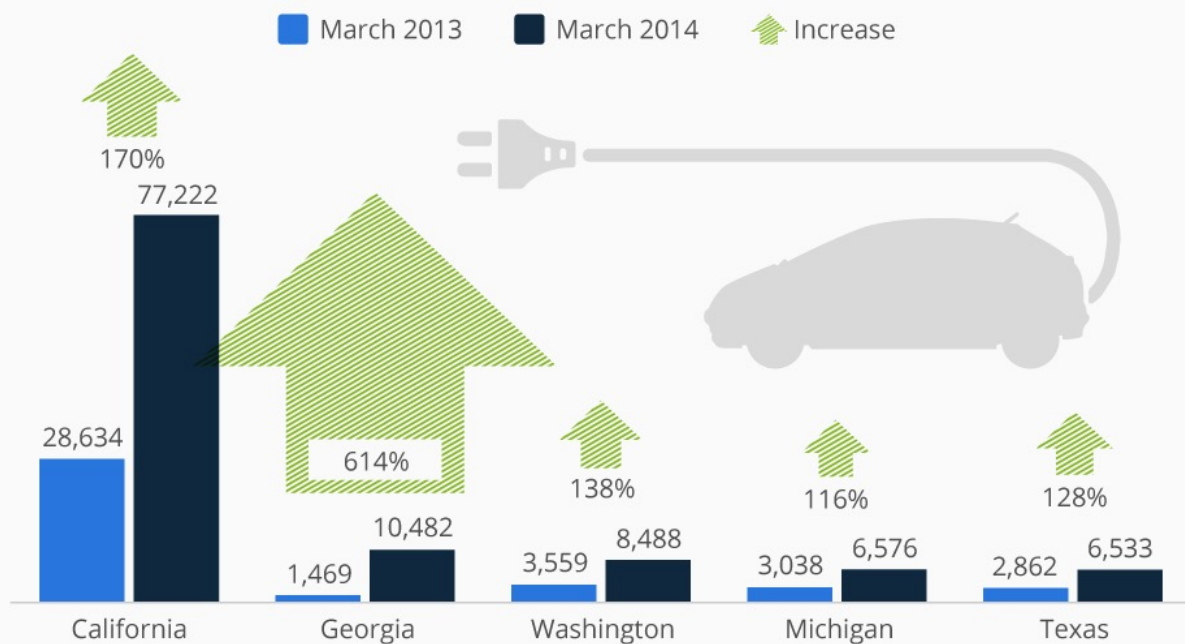


<https://d28wbuch0jlv7v.cloudfront.net/images/infografik/normal/>

[chartoftheday 2886 Electric Car Sales Are Skyrocketing In Georgia n.jpg](#)

Electric Car Sales Are Skyrocketing In Georgia

Registered electric vehicles and percentage growth in the United States



@StatistaCharts Source: Clean Cities

statista



Crowds swarm the Tesla Model S at the Montreal Auto Show in 2016



Electric is the new cool, this is a BMW i8 ripping down Rodeo Drive in Los Angeles