Transportation

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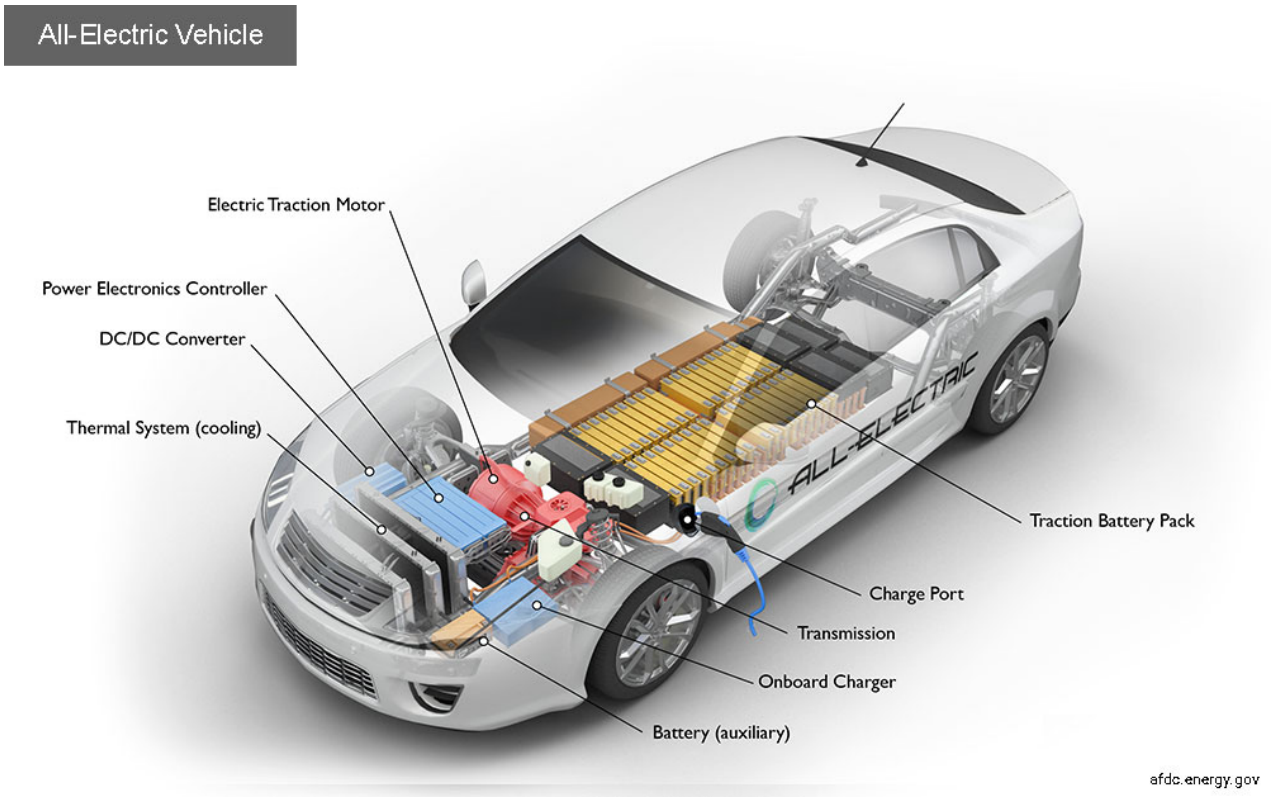
BY WHAT YEAR WILL 51% OF ANNUAL AUTOMOBILE SALES IN THE UNITED STATES BE ELECTRIC?

Overview

Electric vehicles, also referred to as EVs are vehicles that use on or more electric motors for propulsion. EVs can help keep your community cleaner (US Department of Energy). Generally, electric vehicles produce less smog and fewer emissions than conventional vehicles (vehicles that use an internal combustion engine) according to the US Department of Energy. There are two main categories of vehicle emissions, those being direct, and life cycle. Direct emissions are released through the tailpipe and during the fueling process (US Department of Energy). Electric vehicles produce zero direct emissions, which helps improve air quality. Life cycle emissions are “related to fuel and vehicle production, processing, distribution, use, and recycling/disposal”(US Department of Energy). All vehicles produce life cycle emissions, but electric vehicles generally create fewer life cycle emissions because the emissions for electricity generation is lower than the burning of gasoline or diesel.

Electric Vehicle Components and Benefits



Battery: The battery powers vehicle accessories(US Department of Energy).
Charge port: The charge port allows the vehicle to plug into an external power source to charge the battery pack(US Department of Energy).
DC/DC Converter: The DC/DC converter converts higher-voltage DC power from the battery pack to lower-voltage DC power needed to run the vehicle's accessories and recharge the battery (US Department of Energy).
Electric Traction Motor: This motor uses power from the battery pack to drive the wheels (US Department of Energy).
Onboard Charger: The onboard charger takes the incoming AC electricity that is supplied from the charge port and coverts it to DC power to charge the traction battery(US Department of Energy).
Power Electronics Controller: This device controls the flow of electrical energy and controls the speed of the electric traction motor (US Department of Energy).
Thermal System (cooling): This system maintains a proper temperature to keep the electric motor, power electronics, and more operating properly.
Traction battery pack: The traction battery pack stores electricity for the electric traction motor.

Fuel Benefits

While electric automobiles do cost more than conventional vehicles, the fuel costs are much lower. The United States relies heavily on petroleum, and the majority of the petroleum it uses goes towards transportation. The United States' reliance on petroleum makes United States citizens more vulnerable to price spikes (US Department of Energy). Electric vehicles reduce these threats because all of the United States's electricity is produced domestically (US Department of Energy).

Performance, Convenience, Safety, and Maintenance Benefits

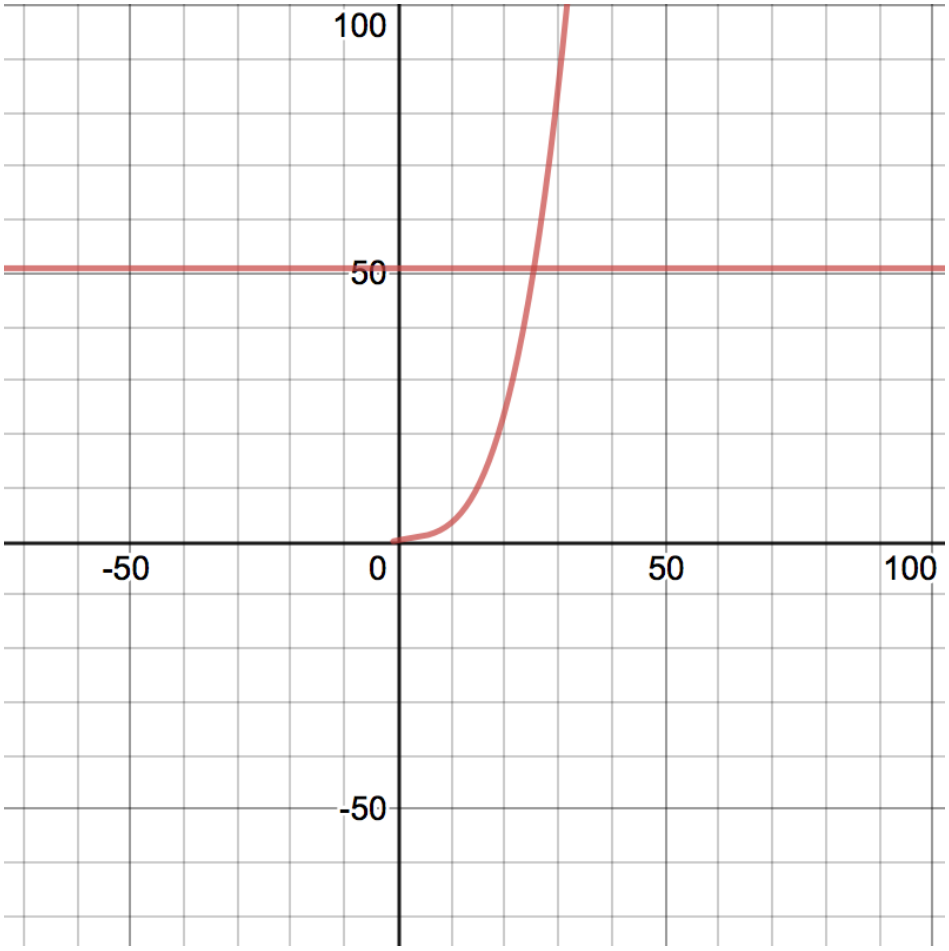
Electric vehicles are very responsive and have great torque due to the fact that their motors react quickly (US Department of Energy). Electric vehicles also do not require gasoline. Instead, you can charge your car from the comfort of your home. Additionally, many companies and public areas have free charging stations. In regards to safety, electric vehicles undergo the same testing as standard conventional vehicles in addition to some EV specific standards (US Department of Energy). Electric vehicles are tested for chemical spillage from batteries, securing batteries during a collision, and separating the chassis from the high-voltage system to eliminate the potential of an electric shock. Additionally, electric vehicles generally have a lower center of gravity than conventional vehicles, reducing the chances of the automobile flipping over during a collision. As for maintenance, electric vehicles cost less to maintain because they usually use fewer fluids and fewer moving parts (US Department of Energy). EVs do not need oil or transmissions fluid changes and their breaking systems last longer than conventional vehicle breaking systems.

Annual Electric Vehicle Sales in the United States

Given all the benefits listed above, the majority of vehicles in the United States are still conventional. Below is a data table that that has statistics on annual vehicle sales in the United States starting from the year 2011.

Year	Total Automobile Sales	Plug-in Electric Sales	% of Vehicle Sales that are Electric
2011	12695712	17763	0.14 percent
2012	15376264	53171	0.35 percent
2013	15490245	97102	0.63 percent
2014	16424017	118882	0.72 percent
2015	17404970	114023	0.66 percent
2016	17500719	159616	0.91 percent
2017	17212565	195581	1.14 percent
2018	17323849	361315	2.09 percent
2019	17023894	326644	1.92 percent

P: Percentage of electric vehicle in the United States annually



t: Year. Year 0=2011

P=0.0037t^(3)-0.0231t^(2)+0.1894t+0.1844 {P>0}

P=51

The data we used to develop the graph seen above are the percentages of annual electric vehicle sales in the United States, and the years. We were originally going to use a exponential equation to graph the data but we noticed that there was a spike in our data so we modeled our data with a cubic function. The r^2 value for the cubic equation was 0.91 and the r^2 for the exponential equation was 0.89. Because of this, we decided to use a cubic equation. It is possible to have negative t values on our graph because 0 is equal to 2011, but we cannot have negative percentages so we put a limit on P. We then graphed the line P=51 and found where it intersected with P=0.0037t^(3)-0.0231t^(2)+0.1894t+0.1844 {P>0} so we could find out when the 51% of automobile sales would be electric. We found the x value of the point of intersection to be 25.45. If we add that many years to the year 2011, we predict that by mid 2036, 51% of vehicle sales in the United States will be electric.

PART 2: WHEN WILL 51% OF THE ANNUAL VEHICLE SALES IN THE UNITED STATES BE TESLAS?

Overview

The electric vehicle is not the only new technology booming in the automotive world. The popularity of self-driving cars continues to grow on a daily basis. Tesla is one of the leading automotive manufacturers when it comes to electric vehicles. Additionally, they are leading manufacturer in the automotive industry when it comes to driver assist features. Tesla blends electric vehicles with innovate autonomous technologies.

The World of Autonomous Vehicles

Autonomous vehicles continue to grow in interest as more and more automotive manufactures jump on the autonomous train. Tesla is one of the leading automobile manufacturers when it comes to electric vehicles and driver assistance features.

Autonomous Vehicles Explained

There are the levels of automative vehicles:

Level 0: No automation.
Level 1: Driver Assistance. In certain conditions, the car controls steering or speed (Car and Driver).
Level 2: Partial Automation. The car is capable of steering, accelerating, and breaking in certain circumstances(Car and Driver).
Level 3: Conditional Automation. In certain circumstances, the car can manage most aspects of driving (Car and Driver). The system prompts the driver to intervene when it cannot navigate certain situation.
Level 4: High Automation. The car can operate without any human intervention in select conditions.
Level 5: Full Automation. The car can perform all tasks in any circumstances (Car and Driver).

Tesla automobiles are more advanced in terms of driver assistance features than most other vehicles on the road today(Tech Crunch). Tesla vehicles are considered Level 2 autonomous.

COMPANY NAME

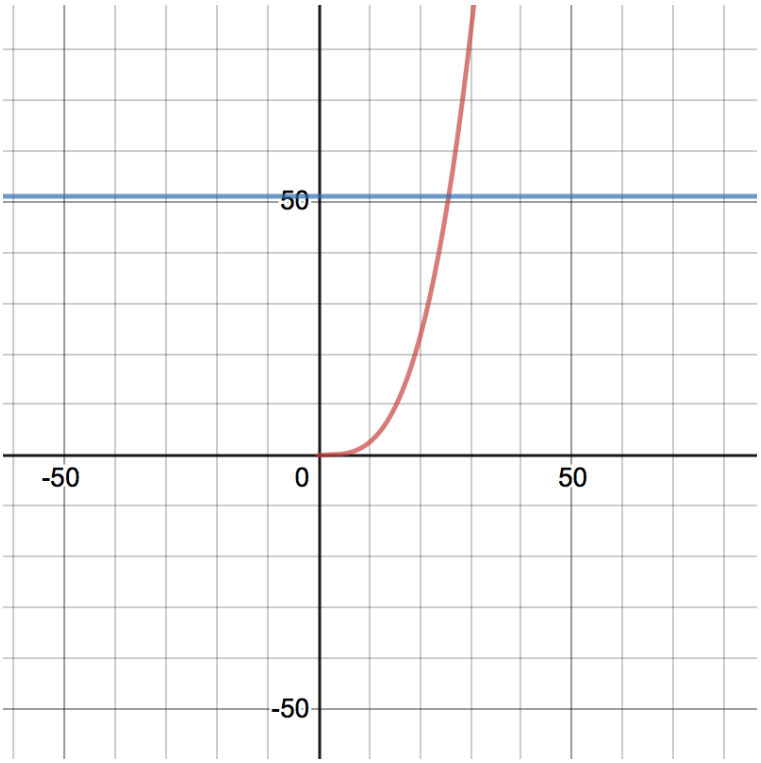
Annual Tesla Sales in the United States

Below are the annual Tesla sales for the Model S, Model X, and Model 3.

Year	Tesla Sales	Total Automobile Sales	Percentage of Tesla Sales To nearest Hundreth
2011	0	12695712	0 percent
2012	2400	15376264	0.02 percent
2013	19400	15490245	0.13 percent
2014	16750	16424017	0.10 percent
2015	26408	17404970	0.15 percent
2016	49800	17500719	0.28 percent
2017	49970	17212565	0.29 percent
2018	191627	17323849	1.11 percent
2019	189355	17023894	1.11 percent

Graph

P: Percentage of annual automobile sales that are Teslas.



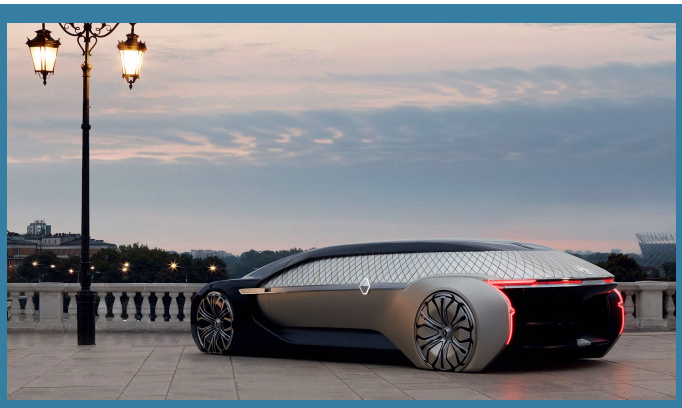
t: Time in years.

Equation: P=0.0035t^3-0.0142t^2+0.0385x+0.0119 {P>0}
P=51

Originally, we planned on using a quartic function to display this data, mainly because it had the r^2 value closest to one. However, after graphing the equation, we noticed that it did not accurately represent our data. The percentages from the year 2014 and onwards steadily increase, but the quartic function after a certain number of years dropped down into negative values which did not accurately show our data. We considered using an exponential function to model our data instead of a cubic function, but to do that, we would have had to alter our data because the exponential function could not have the origin as point with our data. Because of this, we decided to use a cubic function. We found the equation using the TI's features, and then graphed the line P=51. We found where the x value of the point of intersection to be 25.7. We added this many years to the year 2011 and found that 51% of annual automobile sales in the United States will be Teslas by late 2036.

Upcoming Autonomous Automobiles

While Tesla may currently be leading when it comes to driver assistance features in the automobile market, several other manufacturers have developed concept vehicles that we could be seeing in the near future…



Renault EZ-Ultimo

Renault Symbioz

Volvo 360c