WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

IS SLOW CHARGING THE MAJOR CONCERN IN THE CURRENT ELECTRIC VEHICLES?

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ABSTRACT

In recent years, due to increasing pollution and climate change, there has been a big trend toward electric vehicles worldwide. Although electric vehicles have great importance and advantages, people are not quite ready to fully switch to electric vehicles, leaving traditional gasoline vehicles behind for various reasons that do not bring anyadvantage to electric vehicles. Compared to petrol vehicles, charging is slow. One of the biggest reasons. In contrast, where petrol vehicles only take 5 minutes to refuel, most electric vehicles take an average of 20 minutes to charge with the fastest charger that is not readily available while charging with a regular charger takes hours. This study discusses the various reasons why EVs cannot be fast-charged according to people's expectations and possible solutions to overcome this major slow charging problem.

INDEX TERM : Electric Vehicles, Charging, Battery, Fast Charging, battery streak.

INTRODUCTION

Even though Electric vehicles are considered the perfect replacement for gasoline vehicles to control pollution and changing climate, many people are still not completely ready to switch to electric vehicles due to higher price, lower range, and limited options, mainly due to the challenges with charging the electric car. The charging of the electric vehicle is a solid green light for the widespread acceptance of electric cars. However, today, many Electric vehicles face challenges when it comes to charging. According to McKinsey's 2016 EV consumer survey, charging could soon become the top barrier to possessing an EV, especially when EV prices decline while ranges expand.

THE ISSUE WITH EV CHARGING

People are very busy with their work in today's world, so time is a crucial factor that people care about; nobody will want to waste time in the recharging station. Recently a study was done to find the total time taken by the drivers to refuel a vehicle, by the data scientists at Geotab over 6 months based on insights from 14million trips made by over 150,000 vehicles.While calculating the time taken to refuel, two factors were taken into consideration by the scientists.

1)Off-route time (ORT): Time spent off-route traveling to and from the gas station; and

2)Station Dwell Time (SDT): The time spent at the gas station, measured by the amount of time the vehicle was idle.

In this study, total travel time was determined by analyzing all routes in each city and then adding actual visits to gas stations within those routes. The time difference between the same route and the route with the addition of a gas station stop produces an average of the total travel time. The scientists found that the off-road time (ORT) averaged 8 minutes. Station dwell time (SDT) at service stations averaged 12 minutes for all vehicles in the fleet. The effect of ORT and SDT on total travel time was, on average, 20 minutes across all markets.Breaking it down by region, there is a large discrepancy in Total Trip Time, with ORT having the most effect on a metro's Total Trip Time. However, we can ignore the ORT part because, in some places, it can take only a few minutes for traveling to and from the gas station; it depends from place to place. But, the SDT part needs to be considered because it tells us the total time spent at the station, and the researchfound that 8 mins were the average Station Dwell Time. At the same time, electric vehicles (EVs) can take from a minimum of 30 minutes to more than 12 hours.The charging time depends upon the scale of the battery and the rate of the charging point. A regular electric-powered car (60kWh battery) takes simply eight hours to charge from empty to complete with a 7kW charging point. At the same time, electric vehicles (EVs) can take from a minimum of 30 minutes to more than 12 hours. Taking the current best Electric vehicle in the

market, the Tesla Model 3 takes 20 mins on average with a 150kW power source found at public charging locations.So, if we compare it to gasoline vehicles, the EVs take much more time to get recharged.

FACTORS THAT AFFECT THE SPEED OF EV CHARGING

SIZE OF THE BATTERY

In terms of charging durations, battery size and level are obvious; a larger battery requires more time to charge than a smaller one, and an unfilled battery requires more time to charge than a filled battery. The types of batteries used in HEVs, PHEVs, EVs are:

1) Lithium-Ion Batteries

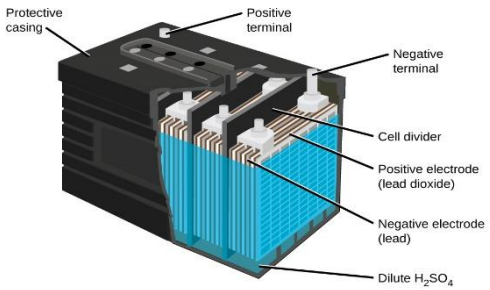
Electric powered strength. Li-ion Batteries Li-ion batteries are presently utilized in maximum transportable customer electronics and molecular telephones and laptops because of their excessive strength consistent with unit mass compared to different battery garage systems. They have an excessiveelectricity-to-weight ratio, excessive strength efficiency, appropriate temperature overall performance, and coffee self-discharge. Most lithium-ion battery additives may be recycled. However, the value of fabric recuperation stays a challenge. The State Department of Energy also helps the Lithium-Ion Battery Recycling Award pick out answers for collecting, sorting, storing, and transporting used and discarded lithium-ion batteries for disposal. Viable recycling and recuperation. Materials. Tiers from batteries to customer electronics. Research and improvement are ongoing to lessen its highly excessive value, enlarge its beneficial lifestyles, and deal with protection troubles related to overheating.

2)Nickel Metal Hydride Batteries

Nickel Metal Hydride batteries, generally utilized in computer systems and scientific equipment, provide affordable unique strength and electric potential. Nickel-metallic hydride batteries have a far longer lifestyle than lead-acid batteries and are secure and tolerate abuse. They are broadly utilized in HEVs. The real demanding situations of nickel-metallic hydride batteries are their excessive value, excessive self-discharge, and excessive-temperature warmness generation, and they want to manipulate hydrogen leakage.

3) Lead-acid batteries

Lead-acid batteries may be designed to be excessive electricity and are economical, secure, and reliable. However, low unique strength, terrible low-temperature overall performance, and brief lifestyles and cycle time avert its use. Advanced excessive-electricity lead-acid batteries are being developed. However, those batteries are most straightforward utilized commercially to be had electric powered motors for auxiliary charging.

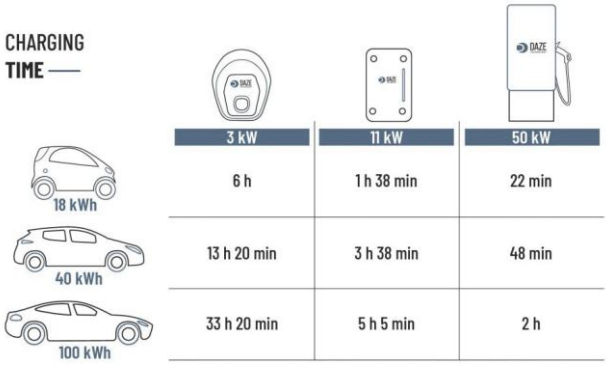


4) Ultra-capacitors

Ultra-capacitors keep strength in a polarized liquid between an electrode and an electrolyte. The strength of garage potential will increase because the floor region of the liquid will increase. Supercapacitors can offer motors extra electricity at some stage in acceleration, mountaineering, and braking strength recuperation.

HIGHEST VEHICLE CHARGING RATE VS. PEAK CHARGE POINT CHARGING RATE

The interaction between the maximum charging rate that the vehicle can handle and the maximum charging rate that a given charge point can spit out is an interesting factor affecting charging time. A 22kW charge point is fine if your EV's maximum charge rate is only 7kW; however, you won't be able to charge any quicker than 7kW. Charging stations are also rated to perform at different rates. Your vehicle will charge at 7kW if it can handle an 11kW charge rate, but you're using a charge point that can only deliver 7kW of current.



ENVIRONMENTAL ELEMENTS

EV charging speed can also be affected by environmental factors. The battery may take a little longer to charge in cold weather. If you're charging with a rapid charger, this effect will be amplified. In cold weather, vehicles are less efficient, so the number of miles added per hour of charging decreases. If your car frequently heats up and cools down after short trips, you'll notice a difference because it takes energy to warm up the cabin and battery.

VARIOUS SOLUTIONS TO TACKLE THE SLOW CHARGING ISSUE

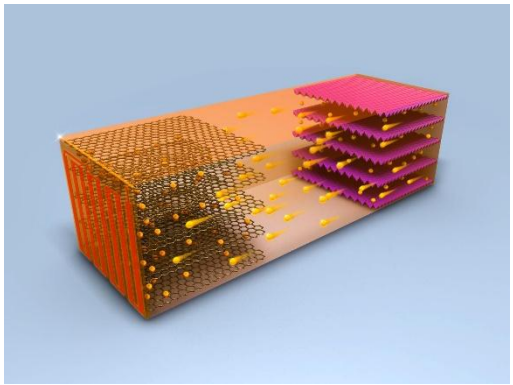
The challenge with imposing excessive current into the existing battery is:

1) Decrease in Battery Life: The chemical breakdowns cause batteries to have a much shorter lifetime.

2) Creates Massive Heat: Current produces heat, hence when excessive current is passed onto the battery it will increase the temperature, therefore, leading to massive heat.

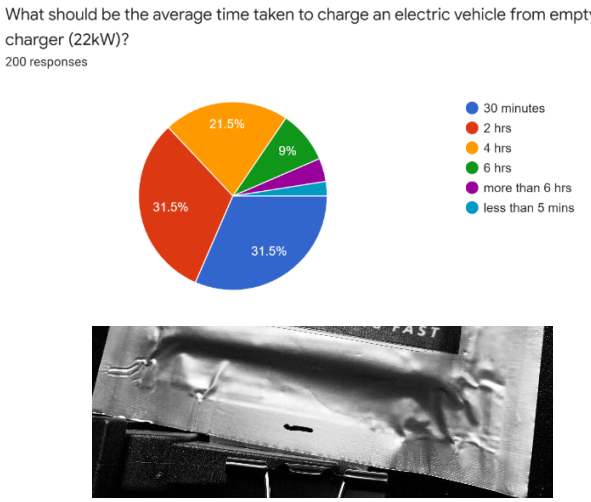
3) Still not that fast: Chemical process is slower so basically although faster it is just not that fast.

Regular lithium-ion batteries cannot be quickly charged at conditions lower than 50 degrees Fahrenheit, but a group of Penn State engineers has invented a battery that can self-heat, enabling speedy charging regardless of the ambient cold. The self-heating batteries employ a thin nickel foil with one end linked to the negative end but the other extending beyond the cell to generate a third terminal. A temperature sensor coupled to a switch enables electrons to flow through the nickel foil to complete the circuit when the heat is below room temp. This quickly heats the nickel foil via resistance heating and warms the interior of the battery. Once the battery's internal temperature is above room temperature, the switch flips open, and the electric current flows into the battery to quickly charge it.



Also last year, a global leader in niobium products bought 20 percent of the company, Battery Streak. The US-based start-up will develop its niobium-containing anode technology. This will allow your battery to obtain an 80 percent charge in under 10 minutes. The business also says their invention might make batteries safer owing to its techniques of managing the warmth while charging. Based on their tests, when charged at a 6C rate at ambient temperature their battery created a thermal gradient of just 8°C/14°F. 25 This is a lot reduced heat production compared to a commercial lithium-ion battery like Panasonic NCR18650PF, which may have an average temperature increase of approx. 27°C/49°F if recharged at a 4C frequency. 26 So a lesser charging rate, but a greater temperature. Besides a better user experience, their approach might assist a lot with a battery pack's temperature

management. This might result in an efficient battery design and cheaper prices for manufacturers.



RESEARCH METHODOLOGY

HYBRID MODEL

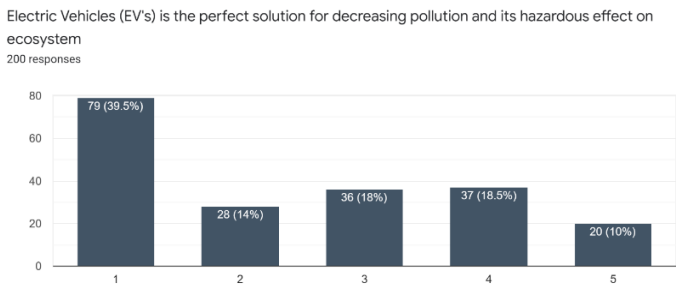
A model may include both descriptive and analytical components.Adescriptive model's logical relationships can be examined and conclusions can be drawn to reason about the system. Nonetheless, the logical analysis yields quite different conclusions than a quantitative chemical investigation of system properties.

We first conducted a poll of 200 people utilizing an online form creator and data collection service to acquire information regarding people's awareness.

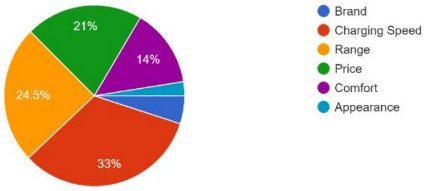
QUESTIONNAIRE

- Electric Vehicles (EVs) are the perfect solution for decreasing pollution and its hazardous effect on the ecosystem
- What feature you will be looking for the most before buying an electric vehicle?
- How much range do you expect from an Electric vehicle per hour of charging?
- What charging method would you prefer?
- What should be the average time taken to charge an electric vehicle from empty to full with a fast charger (22kW)?
- What would you choose?
- Will you consider buying an Electric Vehicle shortly?
- What factors discourage you to consider buying an electric car?
- What should be the main fix so that more people shift towards Electric Vehicles?

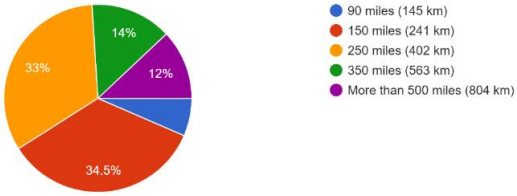
RESULTS



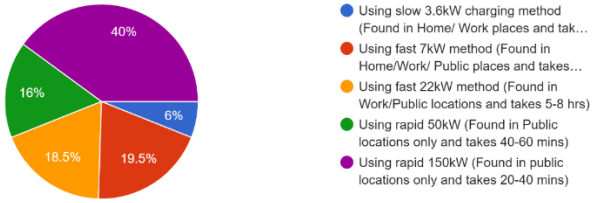
What feature you will be looking for the most before buying an electric vehicle.
200 responses



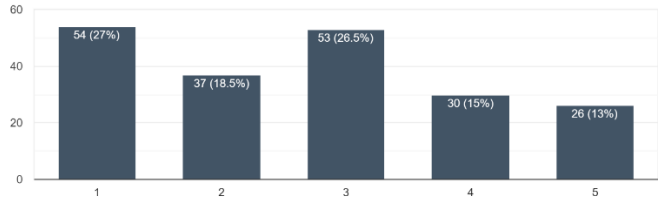
How much range do you expect from an Electric vehicle per hour of charging?
200 responses



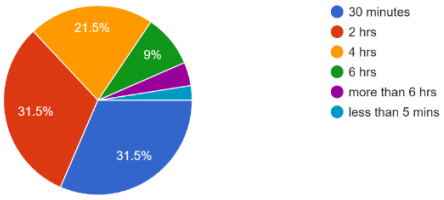
What charging method would you prefer?
200 responses

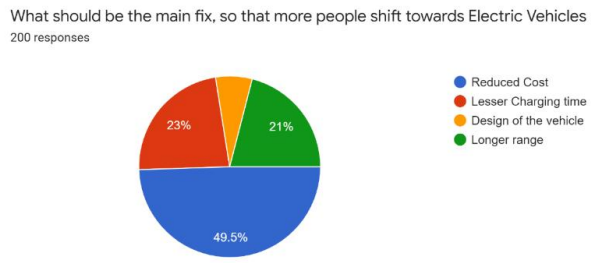


Will you consider buying an Electric Vehicle shortly?
200 responses



What should be the average time taken to charge an electric vehicle from empty to full with a fast charger (22kW)?
200 responses





HYPOTHESIS TESTING

Hypothesis testing is a sort of statistical reasoning that includes analyzing data from a sample to derive inferences about apopulation parameter or probability distribution. First, a hypothesis is created regarding the parameter or distribution.This is known as the null hypothesis, abbreviated as H0. After that, an alternative hypothesis (denoted Ha) is defined, which is the polar opposite of thenull hypothesis. Using sample data, the hypothesis-testing technique determines whether or not H0 may be rejected. The statistical conclusion is that the alternative hypothesis Ha is true if H0 is rejected.

For this paper,

Null Hypothesis (H0): Slow charging is not the biggest challenge in the present EVs.

Alternative Hypothesis (Ha): Slow charging is truly the biggest challenge of present EVs and needs to be fixed.

TEST (STATISTICS)

There are 3 tests available to determine if the null hypothesis is to be rejected or not. They are:

1) Chi-squared test

2) T-student test (T-test)

3) Fisher's Z test.

For this paper, we will be using a 2 tailed T-student test.
A t-test is an inferential statistic that determines if there is a significant difference in the means of two related groups.

- **Level of significance:** The chance of rejecting the null hypothesis when it is true is the significance level (also known as alpha or α). A significance level of 0.05, for example, means there's a 5% probability of discovering a difference when there isn't one. A lower significance level indicates that more evidence is required to reject the null hypothesis.
- **Level of confidence:** The confidence level indicates the probability that the location of a statistical parameter (such as the arithmetic mean) measured in a sample survey is also true for the entire population.

Sr. No.	Data
1	39.5
2	33
3	34.5
4	40
5	31.5
6	60.5
7	27
8	33.5
9	49.5
Mean (x)	38.7777778
Standard Deviation (s)	9.7755679320979

Level of significance = 0.05 i.e. 5%

Level of confidence = 95%
A t-score (t-value) is the number of standard deviations away from the t-mean. distributions.
The formula to find t-score is:

$t = (x-\mu) / (s/\sqrt{n})$

where x is the sample mean,

μ is the hypothesized mean,

s is the sample standard deviation, and n is the sample size.

The p-value, also known as the probability value, indicates how probable your data is to have happened under the null hypothesis. Once we know the value of t, we can find the corresponding p-value. If the p-value is less than some alpha level (common choices are .01, .05, and .10) then we can reject the null hypothesis and conclude that smart devices are not secure and cannot be trusted with our privacy.

Calculating t-value:

Step 1: Determine what the null and alternative hypotheses are.

Null hypothesis (H0): Slow charging is not the biggest challenge in the present EVs.

Alternative hypothesis (Ha): Slow charging is truly the biggest challenge of present EVs and needs to be fixed.

Step 2: Find the test statistic

In this case, the hypothesized mean value is considered 0,

$t = (x-\mu) / (s/\sqrt{n}) = (38.77-0)/(9.775/\sqrt{9})$

=11.899

t-value = 11.899

Calculating p-value:

Step 3: Calculate the test statistic's p- value.

The t-Distribution table with n-1 degrees of freedom is used to calculate the p-value. In this paper, the sample size is n = 9, so n- 1 = 8.

By plugging the observed value in the calculator, it returns a p-value. In this case, the p-value returned is less than 0.00001.

Since this p-value is less than our chosen alpha level of 0.05, we can reject the null hypothesis.So we have sufficient evidence to say that Slow charging is the biggest challenge of present EVs and needs to be fixed.

CONCLUSION

With this study, it is evident that the main reason why people are not fully ready to adapt to EVs is because of the slow charging being the issue. In this busy world where time is everything, one cannot spend hours charging their electric vehicle. But the good news is that the charging issue of the EVs is being taken very seriously by the manufacturers so a big number of researchers and engineers are constantly developing and working hardon the design to make a better battery that can charge faster than the existing also without the components getting heated or damaged in any way, till now various studies and development have been made and the process is ongoing many start-ups are working particularly on this issue of charging and they have seen success. The latest Tesla Model 3 is a perfect example of the improvements being made. With such recent advancements, it is clear that soon the issue with slow charging will be solved, encouraging people to completely swift to EVs in the future.

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