**Calling Bullshit**

The following is the title of a paper written by Bhagavathy et al. that I found in Transport Findings. It was published on March 23rd, 2021:

*Impact of Charging Rates on Electric Vehicle Battery Life*

**I call bullshit on this paper.**

The article, as the authors describe it, comes to the conclusion that rapid and ultra-rapid charging cause more degradation of the “**most common**” electric vehicle batteries than fast charging. The paper comes to this conclusion by synthesizing empirical literature on the impact of charging rates on electric vehicle battery life. To their credit, the authors do acknowledge that the literature is sparse.

In total, the authors of this paper use 4 previous papers. That being said, not all 4 papers discuss and test the same batter type. Papers 1 & 2 discuss an 18650-type NMC battery, while papers 3 & 4 discuss an LFP battery type.

So, what do the four papers find?

Papers 3 & 4, which tested LFP batteries, did not find that charging rates had an impact on battery degradation. Paper 3 found that the battery capacity degradation is almost the same for both low and high charging rates. Paper 4, which is the most comprehensive study of all 4 (performed tests on 200 batteries), found that the experimental results indicated that any loss in capacity was strongly affected by time and temperature and only minimally by charging rates.

Note that earlier I highlighted the words “most common” from the findings of this paper. This is because the author found that capacity of some types of batteries degradation is not affected by charging rates. That being said, the author does not specify why NMC is more commonly used than LFP, but does not cite any statistics of how common or what size of market share NMC batteries are. So basically, the author is hedging his findings based on synthesis literature on only 2 papers.

Papers 1 and 2 do find that charging rates cause degradation of battery capacity. But if we dig further into these two papers, we do find some problems.

Paper 1, tests 5 different charging rates varying between 0.5 C and 1.5 C. (1 C means that the battery can be fully charged in 1 hour, 0.5 C means that half a battery can be charged in an hour, and 1.5 C means that 1.5 batteries can be charged in 1 hour). The total number of batteries tested is 21. Nine batteries were tested at a charging rate of 1 C, and only 3 batteries were tested for each of the other 4 charging rates. Three batteries is way too small of a sample size to come up with a robust conclusion. For charging rates of 0.5C, 0.8C, 1C, and 1.2C, the capacity degradation is 5, 7, 8, and 10% respectively, at 1.5 C, the degradation is 23%. These results could be entirely random simple because of the sample size. The authors in this paper bent over backwards until they were able to obtain a significant value of an F Statistic in their ANOVA analysis. A simple pairwise statistical test between the two most different results would result in a p-value that is higher than 0.5, let alone the significance level of 0.05 used in this paper. This is mostly due to the fact that the sample size is “waaaaay” too small.

Paper 2 also performed tests on NMC battery type (same as paper 1), but they tested a total of 12 batteries. They tested 4 different charging rates, 0.7C, 2C, 4C, and 6C. They found that battery degradation starts at charging rates higher than 4C. Notice that they don’t see any major degradation at 2C, which is still higher than the highest charging rate in paper 1. This at the very least shows two contradictory results in two papers that test the same battery types. Still, the sample size of 3 for each charging rate tested in paper 2 is also “waaaaay” too small. At the very least, paper 2 does not perform any statistical test to check if the results are significant.

In a nut shell, this paper (the one I am reviewing) that attempts to make a finding through a synthesis of empirical literature should not have even attempted to make a finding or generalization. The authors were only able to find to papers that support their hypothesis, and although these two papers reach the same conclusion that higher charging rates cause degradation to electric batteries, and assuming we take the reported findings at face value, the two papers offer contradictory reports at what charging rate degradation begin.

Instead, the finding of this paper should have been the following: “There is still not enough empirical literature to support the hypothesis that rapid charging rates of NMC electric batteries causes battery degradation compared to fast charging, and while the hypothesis may be true, further research and analysis with large enough sample sizes should be done before we can come up with a more robust conclusion”.

For the reasons stated above, I call bullshit on this paper.

**Unfairly Criticized**

The following is the title of an article written by Dave Wasserman that was published on the five thirty-eight website on September 15th, 2016

*How Trump Could Win the White House While Losing the Popular Vote.*

**I would say that this article was criticized unfairly.**

When Dave Wasserman wrote this article, he, along with his article, were heavily criticized by pundits and dunked on by twitter users for his pessimistic and outrageous claims.

There were two major types of criticisms of the article:

The first is that these predictions are very far-fetched and such a scenario is out of the realm of possibilities that average people thought all the stars in the universe would have to perfectly align for this to happen. Most people, even those who thought trump would win just assumed that the electoral college and popular vote would go to the same candidate, which is unreasonable because only 16 years earlier, the scenario described did happen.

The second criticism was that many people, particularly political pundits, and self-professed election experts were counting on a Hillary Clinton electoral landslide. They believed that Hillary Clinton would not only win in Florida, but also in Ohio, Iowa and North Carolina. At the time, it wasn’t even in the realm of possibilities for them to consider that Pennsylvania, Michigan, and Wisconsin would be battle ground states. They were expecting her to win north of 340 electoral votes. It was also being reported that people in Donald Trump’s orbit believed that Clinton would win. After all, Hillary Clinton was running against a TV celebrity who attacked reporters, demonized Muslims, called Mexicans rapists, made fun of a disabled reporter, insulted a gold star family, and attacked prisoners of wars by saying he prefers those who don’t get caught.

Now, the most obvious reason to support the claim that this article was unfairly criticized is that the scenario that Dave Wasserman described did in fact happen.

But beyond that, its clear that Dave Wasserman performed a comprehensive analysis using publicly available data to back up his hypothesis, but more on that later. That being said, Wasserman explicitly said at the very beginning of article that he is not making a prediction, and emphasizing that this is only a possibility. He also said that he continues to predict that Hillary Clinton would have 63% chance of winning the election citing the five thirty-eight election model that completely supported (This was the only model at the time giving Donald Trump a reasonable chance of winning, other prediction models thought the results were basically baked in). However, the model suggested that there was a 6.1% chance that the scenario he described would happen. Sometimes, people conflate statistics where they start to assume that a scenario with only a 6% chance is never going to happen, when in reality it will happen approximately 1 out 16 times.

Moreover, he explained in detail how this scenario could happen, Donald Trump was over performing with non-college educated whites, and he is underperforming a lot with Mormons, and College educated whites, Latinos, and Mormons. According to Wasserman’s analysis using census data and exit poll data, he indicated that college educated whites (group which trump is underperforming) exceed 35% of the electorate in only a handful of states including populous New York and Massachusetts. All these states are either firmly democratic, firmly republican or have no impact on whether Trump crosses 270 electoral votes. So, Hillary Clinton could add to her vote total significantly from the demographic group without affecting the electoral vote count.

Also, Wasserman estimated that Latinos/Hispanics will approximately form a 27.3 million eligible voting bloc. At the time Donald Trump was doing very poorly with this group in polls especially because of disparaging remarks toward this community. However, the majority of this group is under represented in battle ground states. A significant portion of them lives in California, Texas, and Arizona, all which are states with a pre-determined outcome. The only state where they Latino vote may have an impact on the electoral college is in Florida, which Trump needed to win. But Wasserman posited that Trump could win even if he underperformed Mitt Romney in 2012 by 5 points if he overperformed with whites by 3 points, which is a group where he garners the most support. This claim is easily verifiable using simple mathematics and looking up exit poll data and demographic breakdown of the electorate.

Finally, Mormons is the group where Trump is underperforming Romney by a lot, but the majority of this group is in Utah, California, and Idaho, all of which are predetermined.

Therefore, Hillary Clinton could run up the vote counts in states where the outcome already set, but not in battleground states which affect the electoral college.

Therefore, based on the model, he estimated that it would be very reasonable for Trump to hold Romney states and flip Florida, Ohio, and Pennsylvania and Iowa to reach 280 electoral votes (10 more than the required 270). In this scenario, Clinton would win by the popular vote by 1.5 million votes.

In this article, all of his claims were supported by hard numbers that are publicly available and can be easily fact checked if someone had the urge to dunk on him, and therefore the criticism was highly unfair.

If anything, and if the article had to be criticized in retrospect, it would be that Wasserman was very conservative in his estimates. Ultimately, Donald Trump ended up winning 306 electoral votes while losing by 3 millions votes.