McDaniel College

“How Car Buyers Can Estimate If They Would Benefit Fiscally from Buying an Electric Vehicle Verses a Gasoline Vehicle”

Is It Time to Make the Switch?

Melinda Sparks

ANA 510

Prof. Xuejing Duan

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Section 1: Research Question

I've always wanted an electric car. I grew up in an environmentally conscious area, and as a child we learned about alternative energy methods for automobiles. At the time, electric cars were an expensive, luxury item. They weren't particularly reliable in terms of use, and they generally had to be replaced long before the owner could reap any fiscal benefits – particularly since the expected lifetime of a vehicle is 200,000 miles. Essentially, it was an unobtainable fantasy for someone coming from a lower-middle class family.

Since then, over the past 20 years, huge advancements have been made with electric cars. Only five years ago, we would probably still consider an electric car a luxury item – typically in the form of a Tesla. As we enter the year 2022, more and more mainstream automobile companies are producing electric vehicles. Even the first electric truck has entered the market (the Rivian R1T); we can expect the Ford F-150 Lightning sometime this year, and the Chevy Silverado EV by the summer of 2024.

As someone who has always wanted to own an electric vehicle, now is the time to reassess electric vehicles. Car buyers want to know: Is it time to make the switch from gas to electric? **How can I estimate if I would benefit fiscally from buying an electric vehicle versus a gasoline vehicle?**

Section 2: Background

Over the last two years, a dozen or so news articles have come out advocating for drivers to consider making the switch to electric vehicles. A 2020 study from Consumer Report reveals that owners of electric vehicles spend 60% less on fuel than gasoline car drivers. However, a US Department of Energy report suggests that you still only see fiscal benefits after 15 years of ownership, based on the cost of the vehicle, maintenance, financing, tax breaks, and fuel costs.

Based on the average lifespan of a car (200,000 miles) – consumers are anticipated to save approximately $4000 by driving an electric car instead of a gas car (this amount did not include the federal tax credit for some eligible electric vehicle purchases). This is a meager sum when you incorporate all of the unknowns life has to offer. Will I be in an accident tomorrow? Will gas prices suddenly, unexpectedly drop like they did during the nation-wide lockdown of the COVID-19 pandemic?

Like most two-parent households, my husband and I have two vehicles. The first is a small SUV (Ford Escape) and the second is a mid-sized truck (Chevy Colorado). When my husband finally moved up from Texas to join me in Maryland, we ended up swapping vehicles due to our respective commutes. My commute is only 28 miles one-way (~30 minutes), whereas his is 64 miles (~90-120 minutes) one-way. It was a few weeks after he moved up that he asked to drive my vehicle to try and save money on gas – he was refilling the tank every couple of days. Having swapped, we both fill up roughly once a week.

After a few more months driving my vehicle, my husband approached me about selling my car – the Escape – and replacing it with an electric car. I was extremely resistant at first. I was concerned that in the stop-and-go traffic that my husband frequently encounters on his commute that the battery would die, and he would end up stuck on the highway somewhere between home and work. I was also reticent to give up the convenience of our small SUV and trade it in for a compact sedan – something we had specifically gotten rid of for the safety of our infant son. I eventually came around to the idea after he did some research and we’re now considering a purchase.

Section 3: Methods

Originally, I was going to use pre-existing datasets to do my research. Unfortunately, both datasets I found were incompatible with what I wanted them for. The mtcars dataset is a classic learning tool – namely that its contents predominantly cover two-door sportscars from the 1970’s. Additionally, the dataset I found on Kaggle that encompassed information on electric vehicles was unique to vehicles found in Europe. I thought I would be able to just convert the units from metric to imperial, but I quickly realized that the MSRP for an American vehicle in Europe was significantly different than its MSRP here in the States.

In the end, I spent several days collecting data on 140 gas and electric automobiles. I intentionally restricted my collection to gas- and electric-only vehicles – I did not collect data on hybrid vehicles that utilize a combination of gas and electric features. For gasoline automobiles, the variables I included were manufacturer, vehicle model, year of manufacture, MSRP, estimated combined miles per gallon (both highway and city), fuel tank size, anticipated range for a single tank of gas, body type of vehicle, and average tons of carbon dioxide emissions produced annually based on a 15000 annual milage expenditure. For electric vehicles, the variables I included were manufacturer, vehicle model, year of manufacture, MSRP, battery capacity, estimated range of a single battery charge, body type of vehicle, and estimated combined miles per gallon equivalent (MPGe).

Most of my analytical methodology was spent in the creation of 5-year projections for each vehicle – the net cost over time to own each vehicle. I only did four linear regressions to check my work, but they were ultimately too specific for broad use. I did, however, create four models without regression that can serve as a tool for anyone who wants to estimate the annual and aggregate costs when looking to buy a new vehicle.

For these 5-year projections, I used two example commuters and estimated the cost of fuel and electricity for each of them. My daily commute is approximately 52 miles, and my husband’s daily commute is 128 miles. For the weekends, I estimated a generous 20 miles per day. I intentionally overestimated miles for the weekend because I did not want to do additional projections regarding business trips, family trips, weekend trips, etc. My annual commuter projection – referred to hereafter as commuter 1 – was 15,600 miles. My husband’s annual commuter projection – referred to hereafter as commuter 2 – was 35,360 miles.

I took these two commuter profiles and estimated the cost per year by doing the following. For gas vehicles, I took annual commuter projection, divided it by the vehicle's MPG, and then multiplied it by the estimated gas price. NOTE: I estimated gas prices two ways. Firstly, by looking at the average gas price over four years (2017-2020), and secondly by looking at the average gas price in Maryland for the last three months. For electric vehicles, I took annual commuter projection, divided it by the vehicle's range per single battery charge, and then multiplied the result by battery size and the average cost to charge for that amount of energy. NOTE: I estimated energy cost per kilowatt in Maryland based on an article published in *Joule* in July 2020: *Levelized Cost of Charging Electric Vehicles in the United States*.

Section 4: Results

Having developed a simplified methodology to effectively compare comparable vehicles, I developed a series of models that can be used at the consumer-level to determine yearly fuel/energy and net vehicle costs. In this section, I will present these models (tools) and provide examples for how to use and interpret the results of these models so that the consumer can make an informed decision before purchasing a high-dollar item. The first set of models describe annual fuel/energy costs:

Annual cost of gas = annual commute in miles / vehicle combined MPG * cost of gas

Annual cost to charge = annual commute in miles / vehicle battery range *** battery size *** ***cost of energy***

Once you know the results of the above, you can create your own five-year projection using the following models:

Net cost (gas vehicle) = MSRP **+ (*annual cost of gas * number of years*)**

Net cost (electric vehicle) = MSRP **+ (annual cost to charge * *number of years*)**

As an example, the vehicle that my husband and I are considering replacing is our family SUV. If we were to substitute it with an electric vehicle, we would want this replacement vehicle to be the same in as many respects as possible. In other words, we would be in the market for an electric SUV. The top performing electric SUV was the 2022 Hyundai Kona Electric. Because the electric vehicle is new, I want to include a new, comparable gas automobile to complete the comparison – the top performing gas SUV was the 2022 Kia Soul.

Annual cost of gas = annual commute in miles / vehicle combined MPG * cost of gas

$5,223.76 = 35360 miles / 26 miles per gallon * $3.841 dollars per gallon

Per year, we are currently paying approximately $5,200 to fuel our existing 2016 Ford Escape. Using the models above, the projected annual cost to fuel (or in the case, charge) the 2022 Hyundai Kona Electric is approximately $1,500. Comparatively, the projected annual cost to fuel the 2022 Kia Soul is approximately $4,500. Using just the first two models, we can see that based on the cost of fuel/electricity, we would save money buying either vehicle. Yet we would only save $700 a year with the new gas vehicle, whereas we would save $3,700 a year with the new electric vehicle.

However, the fact that electricity costs less than fuel has been true for a number of years. So, if it costs less to charge an electric vehicle than fuel a gas vehicle, why don't more people own electric vehicles? The answer is that electric vehicles generally cost significantly more than their gas counterparts. This is true in the case of the 2022 Kia Soul and 2022 Hyundai Kona Electric, whose MSRPs are $20,505 and $34,000. The difference between these two vehicles is approximately $13,000! We need to definitively see if it's better (a.k.a. costs less money) to own an electric or gasoline automobile. Therefore, the second set of models exist – so we can compare the net cost over time including MSRPs.

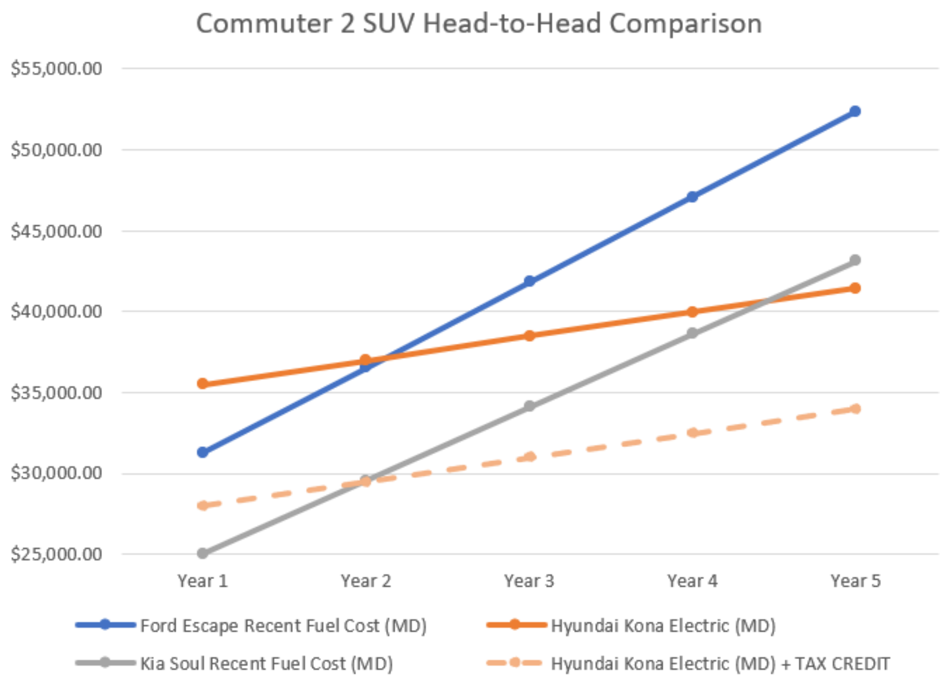

Figure 1: Commuter 2 SUV Head-to-Head Comparison

As you can see, after one year of ownership, the 2022 Hyundai Kona Electric is the most expensive vehicle to own – even when we include what we originally paid for our 2016 Ford Escape. However, as the net cost progresses over the five-year projection, the 2022 Hyundai Kona Electric costs less over time after just two years of ownership. However, it would take approximately 4.5 years to see a similar benefit versus the 2022 Kia Soul. That being said, there is currently a federal tax credit offered for eligible electric vehicles in the amount of $7,500. This was intentionally put into effect by the US government to offset the cost of an electric vehicle. When you take this tax credit into account, you can see that the fiscal benefits of owning the 2022 Hyundai Kona Electric surpass the 2022 Kia Soul after approximately 2 years of ownership.

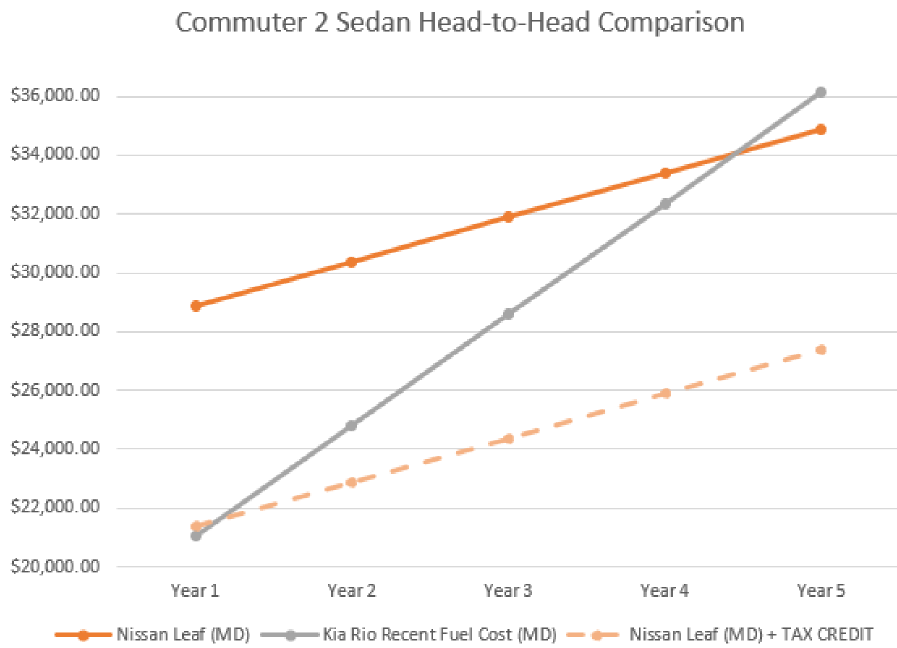

Figure 2: Commuter 2 Sedan Head-to-Head Comparison

The two vehicles modeled in *figure 2* are the most cost effective and energy efficient compact sedans from both electric and gas vehicle datasets: the 2022 Nissan Leaf and the 2022 Kia Rio. As you can see, without the tax credit, the next cost of the 2022 Kia Rio surpasses that of the 2022 Nissan Leaf after about 4.5 years of ownership – the same as the projections for new vehicles in *figure 1*.

Section 5: Discussion and Conclusion

In this report, I have presented tools to drive decision making at the consumer level for those in the market to buy a vehicle. The examples I have demonstrated in this report are based on brand new vehicles, but they can be utilized on any vehicle that is available for purchase; the only exception being hybrid vehicles.

Referencing back to the US Department of Energy's comparative study on the cost of electric vehicles versus gasoline vehicles: Their study indicated that an electric car would only surpass fiscal benefits of a gas car after 15 years. So why does my research show that – worst case scenario – it'll take about 4.5 years to see the overall cost of a comparable gas car exceed the overall cost of an electric car? Most importantly, my research is not nearly as comprehensive as that of the DoE. There is a much larger margin for error on my part.

Even knowing that I am fallible, I was still surprised by the difference in our assessments. I tried to read as much of the study as possible to see where I could have gone wrong. What I found was that at the time the study was published, the DoE indicated that the expected price of a small SUV electric vehicle exceeded $60,000, and their models leveraged this variable extensively.

The electric vehicle in their study was modeled as a small SUV with a range of 300 miles on one charge. The 2022 Hyundai Kona Electric's estimated range is about 250 miles, so I thought maybe that as the key difference, so I went to my electric vehicle dataset to see if there were any SUVs with a 300-mile range. There were two: the 2022 Hyundai Ioniq 5 (MSRP $43,650) and the 2023 Nissan Ariya (MSRP $45,950). Both vehicles are at least $15,000 less than the vehicle used in the DoE's models. Even if we were to acknowledge that the DoE's case study incorporated $5,000 overhead in financing (interest), electric vehicles are still less expensive than they had anticipated.

In conclusion, my provided models will provide a good, rough estimate of what consumers can expect for their net vehicle costs should they buy a new vehicle. Things to consider include that I have not included the cost if a consumer wishes to have a charging station to be installed at their residence – some car dealerships include this in the purchase of their vehicle. Like with all major purchases, consumers should still research their options thoroughly so that they can make informed decisions.

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