

Case Study 04: Should You Buy An Electric Car?

DUE: 22 Apr 2024

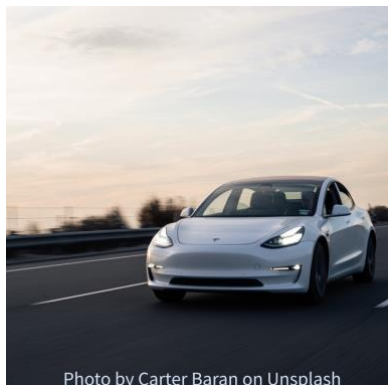


Photo by Carter Baran on Unsplash

It's not unusual to see Tesla Model 3s when you're driving around town!

Introduction

Have you seen a Tesla on the road lately? Chances are you probably have because they aren't that uncommon anymore. You might even know someone who drives one.

Have you seen gas prices lately? Of course you have—every time you need to fill your tank (unless you're driving one of those Teslas). You've probably complained about the cost!

So what about hybrid vehicles? Do you get the best of both worlds if you have a hybrid?

No matter what you choose to drive, cars are expensive to buy. Cars are also expensive to drive, and it's not just fuel that costs you money. There's insurance, for example. And did you know that Arkansas charges an additional \$50.00 registration fee annually for hybrid and electric vehicles?

Let's see if we can analyze the actual cost of owning and operating some vehicles and determine whether an electric or hybrid vehicle is a cost-effective choice.

Let's also think about consequences. These might be harder to quantify, but that doesn't mean they aren't real, and you might be surprised by some of them. In the end, your choice of vehicle is exactly that—your choice. But you can always make a more informed decision.

The Price of Purchase

Step one? Buy a car! Obviously, we can't really buy three brand-new cars to compare. But it's easy enough to research MSRP on three comparable models. Key words: *comparable models*. We all know that every model has different trim levels, from base to sport to luxury. To keep it simple, let's stick to base models.

Although it's not the only one available (google Rivian, for example), the Tesla is the most famous and widely-purchased electric vehicle. So we'll start with that Model 3, and price the base model.

What would be a good comparison hybrid vehicle? Well, you can find hybrid sedans from Toyota, Honda, Hyundai, and other manufacturers. However, according to the [most recent sales data](#), the Tesla Model 3 and the Toyota Camry are the best-selling mid-size vehicles in 2023.

Let's compare the 2024 model year [Tesla Model 3](#) with the [Toyota Camry LE](#) and the [Camry LE Hybrid](#). We know that virtually no one actually pays the full MSRP sticker price, but the new car market has been very volatile lately, and it's getting to the point where people are starting to pay *more* than sticker price! Let's just use the listed sticker price for each model. Also, it's not completely realistic, but let's not try to calculate the cost of financing the vehicle.

1. Look up the MSRP price for each model using the manufacturer websites. Careful! Notice that the listed price for the Tesla is *not* the real price. In the fine print, you will see that the listed price has been discounted by a potential \$7500 tax incentive, as well as \$3000 in "estimated gas savings!" The consumer *will* pay that extra \$10,500 up front, so you must add it to the price quoted!
2. Now pay your sales tax! Arkansas requires 6.5% sales tax, so multiply that MSRP price by 0.065 to calculate what you'll owe.
3. Don't forget to register your vehicle! According to the [Arkansas Department of Finance and Administration](#), there is a \$25.00 fee to register a passenger car weighing between 3001 and 4500 pounds. Add to that the \$2.50 validation decal fee and \$10.00 title fee. Don't forget to include the \$50.00 additional registration fee for the Camry Hybrid and the Model 3!



At 159k vehicles sold, the Camry comes in second to the Tesla Model 3 (256k units sold!)

Vehicle	MSRP (\$)	Sales Tax (\$)	Registration (\$)	Total Purchase (\$)
Example	25,000	$25,000 \times 0.065 = \$1,625$	$\$25 + \$2.50 + \$10 = \37.50	\$26,663
Camry LE				
Camry LE Hybrid				
Tesla Model 3				

The Price of Ownership

Okay, the car is bought and paid for—but you can't just start driving, can you? You'll need insurance. Insurance rates vary wildly from vendor to vendor, and also depend on your age, assets, driving history, what you ate for breakfast...just kidding. It doesn't matter if you eat PopTarts or protein shakes in the morning, but you'll pay more for being young and if you don't meet certain asset thresholds. It's not fair, but it is what it is. Let's just use average values.

4. Use the Car Edge website to get the average values for insuring [the Camry](#), [the Hybrid](#), and [the Tesla](#). Scroll down to the table and use the average annual cost for a Good Driver in the state of Arkansas. Fill in the table below.

Vehicle maintenance and fuel are also part of the cost of ownership, but we can't really estimate how much those will cost until we have a clearer picture of how much wear and tear we are going to inflict on our brand-new cars!

The Price of Driving

This is going to get complicated, but think about your typical driving habits. If you can make some estimates and averages, it will be simpler to calculate how much it costs to drive each vehicle. Let's start with just analyzing your driving habits.

- Do you typically drive the same number of miles each week? Obviously, every week will be a bit different, but do you typically drive to school and your job the same number of times each week? For example, I can say that I drive to campus five times per week with a 9-mile round trip. That's a reliable 45 miles per week.
- Do you typically drive about the same number of miscellaneous miles each week? Shopping, errands, going out, etc. Again, every week is probably a little different, but can you make an educated estimate of the average number of miles? For example, I drive more miles in a week if I go shopping in Little Rock, but I don't go every week. So on average, I estimate that I drive another 55 miscellaneous miles per week, making an average of 100 miles per week.

Maybe you have been driving long enough to have a good idea of how many miles you put on the odometer per year. If you've been driving the same car for a few years, and you're the primary driver, then I'll bet you have a pretty good idea of your average annual miles driven. For example, my estimate above would indicate that I drive about 5200 miles per year. However, my experience tells me that my actual miles are closer to 7000 per year. Why? Well, because when we visit our family Tulsa or go on longer trips, my husband and I will inevitably drive my (more comfortable) car!

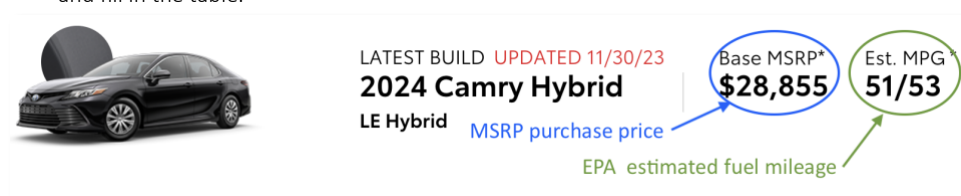
Let's organize the information we've got so far, which is enough to analyze and compare the standard and hybrid Camrys. We'll have to calculate the fuel cost of the Model 3 separately. Even though it doesn't use gasoline, it still requires fuel in the form of electricity, and the batteries will need recharging instead of the gas tank needing to be refilled.

- Estimate your annual mileage, and enter it in the table:

Vehicle	Insurance (\$)	Estimated Maintenance Cost (\$)	Fuel Economy	Annual Miles (miles)	Fuel Cost (\$)	Annual Cost of Ownership (\$)
Example	$\$150 \times 12 = \1800	\$200	30mpg	7000	$\frac{\$3.50}{\text{gallon}} \times \left(\frac{7000\text{mi}}{30\text{mpg}}\right) = \817	\$2817
Camry LE						
Camry LE Hybrid						
Tesla Model 3						

Who knows what gas prices are going to do? To calculate the fuel cost, let's use \$3.50 per gallon for regular gasoline. Regardless of whether this number ends up high or low, it will still allow us to make comparisons.

- Are your miles more city or highway driving? This matters for fuel economy. Notice that the [EPA estimated mpg](#) is two numbers: city/highway. If you do mostly city driving, use the lower number. If you do a lot of highway driving, your mpg will be higher—but it's extremely unlikely that your mileage will really match the high end of the EPA estimate. Explain how you estimated your fuel economy and fill in the table.



LATEST BUILD UPDATED 11/30/23
2024 Camry Hybrid
 LE Hybrid MSRP purchase price
 EPA estimated fuel mileage

Base MSRP* **\$28,855**
 Est. MPG **51/53**

How are we going to make an equivalent calculation for the fully-electric Model 3? Since you never add gasoline, "miles per gallon" is meaningless! However, we can still figure out how much electrical energy the vehicle uses, and how much that energy will cost us.

The base Model 3 has a 50kWh battery pack, and [according to Tesla](#) has an EPA range of 272 miles. That means instead of miles per gallon, we'll calculate miles per kilowatt-hour:

$$\text{fuel economy} = \frac{272\text{miles}}{50\text{kWh}} = 5.44 \frac{\text{mi}}{\text{kWh}}$$

How much does electricity cost in Arkansas? The [U.S. Energy Information Administration](#) collects data on this. Follow the link to the data table and use the current value for residential electricity (because you will be doing most of your charging when you're at home). The residential rate is in cents per kWh, so divide that by 100 to get \$/kWh.

- Now calculate the Fuel Cost for the Tesla and record it in the table above:

$$\text{fuel cost} = \left(\text{residential} \frac{\$}{\text{kWh}}\right) \times \left(\frac{\text{annual miles}}{5.44 \frac{\text{mi}}{\text{kWh}}}\right)$$

Now let's think about the annual maintenance. On a brand-new car, you don't expect a lot to go wrong. But every vehicle needs maintenance, and more miles means more maintenance (if you drive a lot, you might need to replace your tires in the first year!).

- Use the [Car Edge website](#) to find the estimated maintenance costs for the hybrid Camry and the Model 3. Use your own expected annual mileage as the basis for each vehicle.
- Complete the above table and add up the Annual Cost of Ownership for each vehicle.

Summarize and Evaluate!

12. Let's make one more table, just to see all of our numbers in the same place:

	Example	Camry LE	Camry LE Hybrid	Tesla Model 3
Total Purchase (\$)	\$26,663			
Annual Cost (\$)	\$2,817			

13. Which vehicle is the least expensive to own? Are you surprised by these results?

We know that we have made some estimates to make the calculations easier to perform. For example, we assumed that we could pay cash for a brand new car! How realistic is this? Maybe you could...but I know I sure couldn't! And if we have to finance a vehicle for several years (anywhere from 3 to 6 years is typical for a new-car loan!), we're paying interest. Another oversight? Every year, you will have to pay Personal Property Tax on your vehicle (and this is not part of your registration fees!). The greater the value of the vehicle, the more personal property tax you'll be paying.

14. Do your estimates change the overall outcome of the analysis?

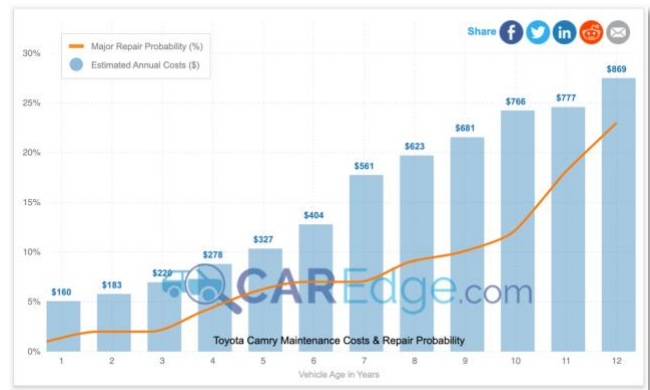
Think about having to finance the car—on which vehicle would you be paying the highest payment (and the greatest interest)?

Let's say that you can make the same \$10,000 down payment no matter which car you choose.

15. What will happen to your annual costs over time? We have estimated based on the first year of ownership. Will insurance premiums increase or decrease? What about gas or electricity prices? How do your maintenance costs change as your vehicle ages?

16. The average length of time a person keeps their brand-new vehicle is between 8 and 9 years. Over this time frame, would the fuel savings of the Tesla offset the greater payments and insurance costs? Justify your answer!

17. Could you calculate this? How could you figure out exactly how long it would take for the overall cost of the Tesla to match the overall cost of the standard Camry? You don't have to perform the calculation, but think about it and explain how it could be done!

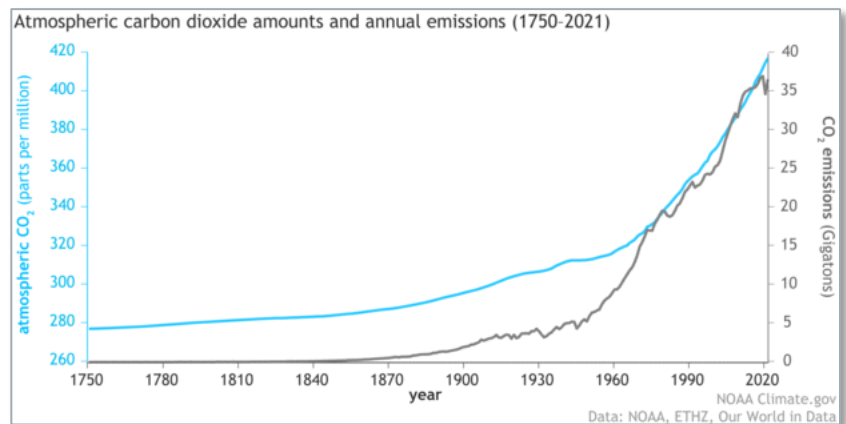


Should We Buy Hybrids or EVs?

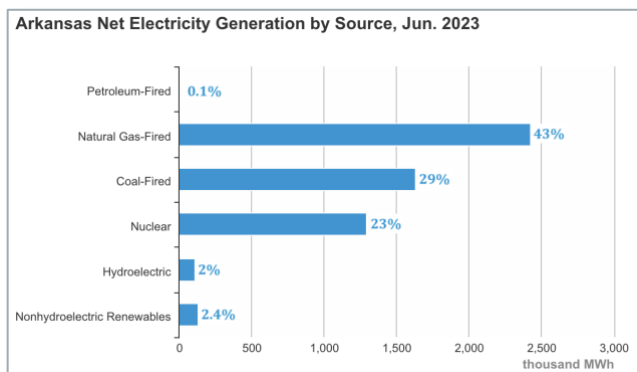
Good question! The point here is not to convince you one way or another, but to help you recognize that the decision can be complicated. Really, really complicated.

Why are you (people in general, not just you) even considering an electric or hybrid vehicle? Chances are that you are aware of the environmental consequences of burning fossil fuels. One of the most compelling arguments in favor of hybrid and electric cars is their reduced carbon emissions.

18. Examine the graph on the right. While scientists understand that correlation does not mean causation, there's no arguing that CO₂ emissions start shooting skyward (pun intended) at the dawn of the 20th century, which is also the dawn of the Automobile Age. Regardless of whether passenger cars are partially responsible for the CO₂ spike, is it a good idea not to make the problem worse? Is a more expensive vehicle worth it to help keep the problem in check?



According to the U.S. Energy Information Administration, the state of Arkansas generates 72% of its electricity using fossil fuels (natural gas and coal) and 23% of its electricity via nuclear energy. Unless you have a solar installation on your property (and most of us do not), when you charge your electric vehicle you are not using a renewable resource—there are indirect emissions associated with your vehicle!



19. Does this information further complicate your decision? What is your personal threshold or tipping point? When do the benefits outweigh the costs?

The lithium-ion batteries used by EVs and hybrids (as well as in all your other electronic devices!) aren't actually very friendly to the environment. Mining and manufacturing processes are not kind. And we have not even started thinking about the end stage—recycling and disposing of those batteries is yet another environmental issue!

20. Do these environmental impacts affect your decision? Maybe it feels like buying a single vehicle can't possibly make a difference on a global scale. But consider that worldwide, [85.4 million vehicles were manufactured in 2022](#). Are you starting to think that some of these issues should be policy decisions and not the personal responsibility of the individual consumer? Why or why not?
21. So what's your final choice? Are you (hypothetically, of course) going to buy the cheapest Camry or the Model 3? Or maybe opt not to buy any car at all? Briefly explain your decision and what influenced you the most in making it.

Put It Together and Hand It In!

This Case Study is due on **Monday, 22 April 2024, no later than 6:00PM.**

To prepare your case study for evaluation, create a neat, easy-to-follow document that addresses each of the questions completely. Creating a Google doc that can be shared within your group is a great idea for allowing everyone to have access and be able to contribute to the document. Use tables to organize your numeric results!

Please take a few moments before you submit to make sure that your document is neat, complete, and professional. Proofread it for spelling and grammar (then have another person do it again!). Make sure the questions are numbered, any figures or tables are labeled, and that the document is easy to read.

To submit your case, export the document as a pdf. Blackboard does not recognize a Google doc as an allowable file format for submissions. Use the Blackboard assignment to upload your work, and submit only one document for the entire group. Each Case Study is worth 50 points, and all participating group members will receive the same score.

Remember that you are permitted to self-select your groups, and if you find yourself on a team that isn't your best fit, you can choose to work with different people on the subsequent cases. You are not required to work with the same team each time, but once a team is formed, it's for the duration of the Case.

Scoring Rubric

Your Case Study will be evaluated using the following scoring rubric:

QUESTION	CRITERIA	COMMENTS	POINTS POSSIBLE	POINTS EARNED
1	Table is complete and calculations are correctly performed		8	
2				
3				
4	Table is complete and calculations are correctly performed		2	
5	Response makes sense in the context of the question		2	
6	Response makes sense in the context of the question		2	
7	Calculations are correctly performed and recorded in table		2	
8	Calculations are correctly performed and recorded in table		2	
9	Calculations are correctly performed and recorded in table		2	
10	Calculations are correctly performed and recorded in table		2	
11	Calculations are correctly performed and recorded in table		2	
12	Table is complete and calculations are correctly performed		4	
13	Response is justified		2	
14	Reasoning is well-thought out and fully explained		3	
15	Reasoning is well-thought out and fully explained		3	
16	Reasoning is well-thought out and fully explained		3	
17	Proposed calculation makes sense and could be performed		4	
18	Opinion is clearly explained		3	
19	Opinion is clearly explained		3	
20	Opinion is clearly explained		3	
21	Opinion is clearly explained		3	

Yes, this adds up to more than 50 points. There are five bonus points here! Grab them while you can!

Sources

Toyota Camry: <https://www.toyota.com/camry/>

Toyota Camry Hybrid: <https://www.toyota.com/camry/hybrid>

Tesla Model 3: <https://www.tesla.com/model3/design-overview>

Compare Teslas: <https://www.tesla.com/compare>

World Best Selling Mid Size Cars 2023: <https://www.focus2move.com/world-best-selling-mid-size-cars/>

Arkansas Department of Finance and Administration:

https://www.dfa.arkansas.gov/images/uploads/motorVehicleOffice/schedule_fee1.pdf

Average Price of Electricity to Ultimate Customers by End-Use Sector:

https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=epmt_5_6_a

Car Maintenance Costs by Brand: <https://caredge.com/maintenance>

How Long Do People Keep Their Cars?: <https://www.iseecars.com/how-long-people-keep-cars-study>

Climate Change: Atmospheric Carbon Dioxide: <https://www.climate.gov/news-features/understanding-climate/climate-change-atmospheric-carbon-dioxide>

Arkansas State Profile and Energy Estimates: <https://www.eia.gov/state/?sid=AR#tabs-4>

The Paradox of "Clean" EVs and the "Dirty" Lithium Mining Business: <https://interestingengineering.com/science/clean-evs-and-dirty-lithium-mining-business>

World motor vehicle production: <https://www.acea.auto/figure/world-motor-vehicle-production/>