Electric Vehicles: Battery Trends and Future Economics

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By

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Electric Vehicles: Battery Trends and Future Economics

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Abstract:

A common question coming from many automobile companies is how current electric battery trends and changes will benefit the future of the electric car industry. Since the inception of Tesla and their Model 3 luxury EV, the industry has seen a sudden shift in the willingness of the population to invest in electric vehicles. Through generous subsidies given by governments around the globe to an increased importance placed on cleaner energy, there has been a very visible change in the perception of Electric Vehicles, corresponding with an increase in sales and Research and Development by automobile companies. If the EV trend is to continue, there will need to be a decrease in cost so that more of the population can afford these generally high-priced automobiles.

This document will present the best way to mitigate EV costs; by creating cheaper batteries. Batteries have long been expensive to create, and the infrastructure of the world has not done any favors towards the thought of using electric vehicles over the stable yet unspectacular gasoline-based ones. Current trends see Government's adding more super-charge stations at various, convenient locations, which could make using EV's all the more viable. Should EV prices decrease, we could see an economy, a continent, and eventually a world switch towards using electricity over gasoline.

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Introduction:

It's here, and it's big. It's been around for a while, a thought for even longer, but it's now starting to truly blossom. Many have tried and few have truly succeeded, but future success could drive a company for decades. I'm talking about the electric vehicle (EV) age.

In this thorough document I plan to outline the electric vehicle, or EV industry. I will zoom out in a broad scope and look at the entire industry, and attempt to compare the beginning of the EV industry to the inception of the automobile industry. I will then hone in on one area of growth in the EV industry that manufactures are focusing on; the battery component. After outlining the importance of batteries within EV's and the current market research and gold standard on pricing and storage of these batteries, I will further my research with financials. I will take the past few year income statement financials for a large automobile company that has seen stable financials over the last decade, Nissan. I'll also take the past few year income statements for Tesla, the almost mythological company that started the EV trend. With these income statements, I will use the current trend prices for batteries and hone in on how cars are being produced for cheaper prices year over year. I will then take the income statements and project the future (approximately 3-5 years out) of each company. With this data I will have enough info to logically assess how current and future battery trends will alter and change the automobile industry for years to come.

Chapter 1: How and Why

The current electric vehicle market is being dominated by Tesla. With Tesla's newfound excellence in the EV sector, many companies are pushing to find out exactly how this company makes such quality vehicles that the public *wants* to buy. "Wants" is the keyword here. Electric Vehicles have been around for a few years, so why the sudden interest by the public?

Part of the sudden interest in EV is due to the lack of fossil fuels in the world – even with the increase in oil production through new technology that allows for deeper and more concentrated drilling, no one can argue that our supply of oil is dwindling. Recent research suggests that, with world consumption at just over 11 billion tons of oil per year, "known oil deposits could run out in just over 53 years."[1] This is obviously a staggering realization and calls for not only immediate attention but also quick change. In addition, it becomes the job of first-world countries to adapt to different energy because many third-world countries cannot. Due to low GDP's and uneconomically sound infrastructure, it just is not feasible for some of these countries to shift their energy use on the blink of an eye.

This, however, could be a totally different thesis should I choose to focus on the above outline. Rather, my focus is on the reasons the population is now beginning to want these electric vehicles. In addition to dwindling oil supply, this is a generation that focuses on a cleaner environment. Individually, I have seen many college students lead the pack in recycling, landscape cleaning, and all other kinds of environmentally friendly initiatives. Through these alterations to modern living, we see just how much the current and upcoming generations of the world want to make the future of the planet brighter.

[1] "The End of Fossil Fuels." Ecotricity. Accessed May 5, 2020. https://www.ecotricity.co.uk/our-green-energy/energy-independence/the-end-of-fossil-fuels.

Part of the problem with electric vehicles has been the unfeasibility of them in the past. Electric vehicles not only can cost more than their standard gasoline-based equivalents, but the vehicles also involve an entire life switch. With vehicles that now require charging, the ability to get up and go to the city or even across town cannot just be a spur of the moment idea; rather it must be calculated the night prior, involving charging of the vehicle and calculations to make sure there will be enough power to get to and from the destination. While no one argues the electric-based fuel is cleaner (based off of all sorts of energy sources – wind, solar, hydro, nuclear, and fossil fuel), there have been many valid arguments stating that the electric-based idea in this current economy is just not an option. This is where Governments and Companies alike are stepping in to lead the charge. Numerous Governments have given subsidies to EV companies trying to kick start their future. One such is Nio, an electric vehicle startup that has become quite popular in China. "Since its founding in 2014… the company [has been trying] to survive by rapidly raising new funding."[2] As a researcher of the stock, I myself can attest to just how many attempts Nio has made to garner new support. Most recently, amid the global Coronavirus pandemic, Nio "has entered into a framework agreement with the municipal government of Hefei, the capital of China's Anhui province."[3] The agreement has been referred to as a "bailout" set to inject the company with much needed money to stay afloat. Many of these kinds of deals have been made with EV startups, most as direct subsidies from home governments.

[2] O'Kane, Sean. "NIO's New SUV Can't Save the Company from Its Current Problems." The Verge. The Verge, December 30, 2019. https://www.theverge.com/2019/12/30/21043027/nio-ec6-suv-q3-finances-earnings-cash-fundraising.

[3] O'Kane, "Nio's Current Problems"

In addition to the subsidies that these governments are attempting to offer startup EV companies, many governments are also attempting to augment consumer interest by extending tax credits to those purchasing new electric vehicles. In the United States alone the Government has been offering "a federal tax credit [of] $7,500" to those who purchase a qualifying electric vehicle.[4] This does not include rebates and incentives that state governments individually push out to their constituents who choose to purchase eligible vehicles. There are problems with this tax benefit however that might merit consideration for future EV support. Typically, the majority of eligible vehicles are only new off-the-lot purchases. These vehicles currently still cost a bit more on average than their gasoline-based counterparts. Because of this, most vehicles are bought by those who earn a higher income, creating a paradox of sorts for what the benefit should incentivize; those who may not need the tax benefit are the only ones receiving it. Someone who might buy a used EV on the other hand would not receive the incentive, opening up an air of controversy on whether the tax credit really only benefits those with already high income.

There are also some less controversial methods to spur demand being done by large companies and governments alike. Perhaps even bigger than tax credits and write-offs, supercharge stations are popping up all over the United States. Electrify America is a company that is aiming to create the broadest charging networks found in the entire world. They are attempting to have "approximately 800 total charging stations… [and] 3,500 total chargers… crossing 42 states from coast to coast" by December of 2021.[5] These charging stations could be

[4] Research, Car and Driver. "What Is an Electric Vehicle Tax Credit?" Car and Driver. Car and Driver, March 22, 2020. https://www.caranddriver.com/research/a31267893/electric-vehicle-tax-credit/.

[5] "About EV Charging." Electrify America. Accessed May 5, 2020. https://www.electrifyamerica.com/about-ev-charging.

the greatest game changer of all for the EV industry; even as big as Tesla revolutionizing the industry a few years back. These charging stations will be based on DC, direct current chargers, and each station will include a plethora of plug-ins to fit virtually any EV. Even more interesting than the universality of the supercharge station is the speed at which these vehicles will be able to charge. Electrify America reports speeds "ranging from 50kW up to 350kW" for vehicles that can support this type of speed. For other, older vehicles, AC, alternating current charging, will be offered. AC offers speeds of approximately 3.3kW to 19kW, typical overnight charging speeds. Interestingly enough, some of the fastest "chargers will be available at charging stations near highways."[6]

Electrify America is not the only company that is hopping on the EV bandwagon either. Top projected companies in this field happen to be giants in the petroleum business as well, companies such as Shell and BP. And, fascinatingly, Hyundai and Kia have partnered to "develop a wireless electric vehicle charging system."[7]

The revolutionary invention of supercharge stations is so important because it eliminates perhaps the main concern of EV's: the lack of quick recharge. One of the biggest problems with EV's, as explained earlier in this report, is that the owner has to plan ahead for long trips. As I will explain later with battery storage, EV's can only travel so far on one charge. If a car runs out of electricity, it's not as simple as heading to the gas station for a quick fill-up. With supercharge stations spread across the country however, it may soon be that easy. An eager traveler may be able to plan a long trip, plug their vehicle in overnight, drive for a few hours, stop for an hour to

[6] Charging, "ElectrifyAmerica"

[7] Francis, Sam. "Top 20 Electric Vehicle Charging Station Companies." Robotics & Automation News, November 27, 2019. https://roboticsandautomationnews.com/2019/05/01/top-20-electric-vehicle-charging-station-companies/22138/.

quickly recharge their vehicle, and finally drive the rest of the trip. This would be a complete gamechanger for the EV market, and, with a widely untapped market, seem to usher in an unprecedented battle between Oil and Gas tycoons and optimistic startups trying to cash in on the need for vehicle energy.

Chapter 2: Battery Changes

With the planned emergence of a wide network of supercharge stations across the country, a question does arise. What about those in rural areas that travel long distances but don't have the almost instant access to charging stations that those living in cities and urban areas have? Does the EV dream become unattainable? After all, these areas are often broad, and those living in them can travel long distances to even get to a "local" grocery store. This is where the main focus of this research paper comes into play: Battery enhancements.

With the recent "Tesla effect", that is, what professionals are calling the unprecedented change in not only the EV market but also the luxury vehicle market (after all, Tesla vehicles now rival Mercedes, B&W, Lexus, and other top-end vehicles), the world has seen a huge increase in not only battery performance but also battery storage. Tesla has revolutionized the battery industry as well, terming their own, in-house lithium-ion battery line the "PowerWall series."[8]

Problems with lithium-ion batteries have been well documented. Though they are the current and future gold standard for batteries, enhancements have lagged behind other technological innovations. For instance, Apple is creating smaller and smaller processing chips that run faster than their larger predecessors. However, the battery "takes up most of the available space" of the phone.[9] This is due to the instability and unstable nature of lithium – it must be protected from outside manipulation while being utilized, "properly sealed and secured" so that tampering is almost inconceivable. The nature of a battery in an automobile only accentuates the problem. Automobiles need to be capable of withstanding ferocious collisions

[8] Hayes, Adam. "The Economics of Tesla Batteries." Investopedia. Investopedia, January 29, 2020. https://www.investopedia.com/articles/investing/050715/economics-tesla-batteries.asp.

[9] Hayes, "Economics of Tesla"

and accidents, and therefore the batteries must be protected at a premium. This, no doubt, costs a pretty penny.

By adapting solar-technology for storage that other companies are also attempting to utilize, the PowerWall has been wildly successful. Tesla continues to produce updates every year or two, and costs for the company can range in the mid $5,000's per battery. These batteries are capable of storing "approximately 60 kilowatt-hours of electrical capacity."[10] (Research says that current Tesla's are attempting 75+ kWh.) For comparison, one of the first EV's that was mass produced, the Nissan Leaf in 2010 had a "21.2kWh [battery] with a range of 73 miles."[11] This calculates to an average of approximately 3.5 miles per kWh. With this same ratio, the average PowerWall battery would be able to obtain a maximum range of 200+ miles per full-charge. With this kind of battery storage, it's no wonder that Tesla has been able to revolutionize the EV market, making EV's viable for anyone, no matter the location of their home.

[10] Hayes, "Economics of Tesla"

[11] "Nissan Leaf." Wikipedia. Wikimedia Foundation, May 2, 2020. https://en.wikipedia.org/wiki/Nissan_Leaf#First_generation_(2010–2017).

Chapter 3: Tesla Analysis

This next section will focus on the analytical breakdown of battery enhancement benefits for both the companies utilizing them and the consumers purchasing them. First, I utilized CapitalIQ to broadcast Tesla's reported financials from the past four years – 2016 through 2019 – and created a brief Income Statement showing key factors for each year.[12]

	12 months Mar-31-2016	12 months Mar-31-2017	12 months Mar-31-2018	12 months Mar-31-2019
Sales	7,000.1	11,759.0	21,461.0	24,578.0
COGS (incl. D&A)	5,400.9	9,536.0	17,419.0	20,509.0
Gross Profit	1,599.3	2,223.0	4,042.0	4,069.0
SG&A	1,410.5	2,477.0	2,835.0	2,646.0
R&D	834.4	1,378.0	1,460.0	1,343.0
EBIT	(645.6)	(1,632.0)	(253.0)	80.0
Interest Expense	(191.8)	(477.0)	(653.0)	(725.0)
Pre-tax Income	(837.40)	(2,109.00)	(906.00)	(645.00)
Income Taxes	26.7	32.0	58.0	110.0
Noncontrolling Interest	-	-	-	-
Preferred Dividends	-	-	-	-
Net Income	(674.9)	(1,962.0)	(976.0)	(862.0)
Effective Tax Rate	NM	NM	NM	NM
Weighted Avg. Diluted Shares	144.2	166.0	171.0	177.0
Diluted EPS	($4.68)	($11.83)	($5.72)	($4.92)
Depreciation & Amortization	-	-	-	-
EBITDA	301.5	4.0	1,648.0	2,187.0

I was able to find sales, cost of goods sold, and all the typical expenses for a company such as Tesla. Coming to our EBIT, earnings before interest and taxes, we can see that Tesla actually hasn't been positive until this past twelve months of 2019. This is pretty standard for a start-up company, but interesting to note for such a "darling" company. A good question would be

[12] "S&P Capital IQ." Accessed February 10, 2020. http://capitaliq.com/.

whether most uninformed investors know that they have invested money in a company still in a LOT of debt. This income statement also notes that Tesla has produced negative Earning per share, but, as is well documented, Tesla stock continues to rise weekly. (Save the Coronavirus market crash that has impacted nearly every single publicly-traded company.)

Putting the income statement aside, I next decided to calculate the average cost to produce a single kWh of storage capacity in a battery. Before I go over the calculations, it's important to note from where I obtained my numbers. Bloomberg reports that, as of December 3, 2019, battery prices had "fallen 87% in real terms to $156/kWh [and,] according to the latest forecast… [would have] average prices close to $100/kWh" by the year 2023.[13] Bloomberg also reports that the average price per kWh in 2010 was "above $1,100." With this info, I created a table that could predict the average price per kWh between 2010 and 2019, and from 2020 on. As shown in the table below, the average change from 2010 to 2019 would have been a total change of over $900, over a nine-year period coming out to an approximate $105/year. Overall this was an 85% decrease in total price per kWh, with a 9.5% decrease estimated annually. Next, with an estimate of approximately $100/kWh in 2023, we could assume from 2019-2023 that there would be a total change of $56/kWh, a 35.9% change over the four-year period. This would come out to an approximate change of 9% per year, or a decrease in $14/kWh.

[13] "Battery Pack Prices Fall As Market Ramps Up With Market Average At $156/KWh In 2019." BloombergNEF, December 3, 2019. https://about.bnef.com/blog/battery-pack-prices-fall-as-market-ramps-up-with-market-average-at-156-kwh-in-2019/.

Year:	Cost / Kwh		
2010	$ 1,100.00	% Change (2010-19)	85.82%
2011	$ 995.11	Per year change ('10-19)	9.54%
2012	$ 890.22	Total Change $ ('10-19)	$ 944.00
2013	$ 785.33	Change / yr $ ('10-19)	$ 104.89
2014	$ 680.44		
2015	$ 575.56		
2016	$ 470.67		
2017	$ 365.78		
2018	$ 260.89	% Change (2019-23)	35.90%
2019	$ 156.00	Per year change ('19-23)	8.97%
2020	$ 142.00	Total Change $ ('19-23)	$ 56.00
2021	$ 128.00	Change / yr $ (19-23)	$ 14.00
2022	$ 114.00		
2023	$ 100.00		
2024	$ 86.00		
2025	$ 72.00		

With this change calculated per year, my next plan of action was to find out approximately what percentage of vehicles sold per year would be electric. A recent study conducted by JP Morgan Chase concluded that a reasonable estimate for the year 2025 would be approximately 30% of all total sales. Chase even tells us that by year 2030, pure ICE vehicles (standard internal combustion engines) will hold a share of only "around 40%" of new vehicle sales.[14] Because of the standard Chase has set in the past, though these are quite drastic forecast, they cannot be ignored, and so they form the basis for my next analysis.

[14] "Driving into 2025: The Future of Electric Vehicles: J.P. Morgan." Driving into 2025: The Future of Electric Vehicles | J.P. Morgan. Accessed May 5, 2020. https://www.jpmorgan.com/global/research/electric-vehicles.

Average % per year:	2.5%	Tesla % Change per year:
2019	15.0%	-
2020	17.5%	16.7%
2021	20.0%	14.3%
2022	22.5%	12.5%
2023	25.0%	11.1%
2024	27.5%	10.0%
2025	30.0%	9.1%

Assuming the JPMorgan prediction of 30% of all 2025 vehicles sold being electric and a growth rate of 2.5% per year, we can assume that the current percentage of new vehicles purchased is right around 15%. Though it's not feasible to have an exact percent change of the same rate per year, this kind of reasonable assumption of course allows us to carry on with the analysis.

To the right of our percentage per year, I was able to calculate the percent change per year in Tesla's sales. Though this won't be used in my overall analysis of battery cost savings, it does give us a pretty accurate look at how Tesla projects its sales to grow going forward. Again, these numbers, approximately 12.5% change per year, do not seem to be unreasonable by any means. It's also interesting because we see how, as the market becomes more EV reliant and the growth overall begins to slow down, Tesla's percentage growth will also begin to decrease. Make no mistake, Tesla's growth will be directly correlated with the popularity of electric vehicles.

With this prediction of sales percentage per year calculated, we can now move on to project overall sales. We are getting closer to our overall analysis, showing how Tesla's current battery economics, allowing for nearly $156/kWh battery production, compares to earlier prices for batteries and how companies and consumers alike thus save money.

The next individual part of a Tesla analysis will be focusing on their projected growth going forward.

	Mar-31-2020	Mar-31-2021	Mar-31-2022	Mar-31-2023
Sales	28,674.3	32,770.7	36,867.0	40,963.3
COGS (incl. D&A)	23,927.2	27,345.3	30,763.5	34,181.7
Gross Profit	4,747.2	5,425.3	6,103.5	6,781.7
SG&A	3,087.0	3,528.0	3,969.0	4,410.0
R&D	1,566.8	1,790.7	2,014.5	2,238.3
EBIT	93.3	106.7	120.0	133.3
Interest Expense	(845.8)	(966.7)	(1,087.5)	(1,208.3)
Pre-tax Income	(537.5)	(460.7)	(403.1)	(358.3)
Income Taxes	128.3	146.7	165.0	183.3
Noncontrolling Interest	-	-	-	-
Preferred Dividends	-	-	-	-
Net Income	(718.3)	(615.7)	(538.8)	(478.9)
Effective Tax Rate	NM	NM	NM	NM
Weighted Avg. Diluted Shares	164.6	164.6	164.6	164.6
Diluted EPS	N/A	N/A	N/A	N/A
Depreciation & Amortization	-	-	-	-
EBITDA	2,551.5	2,916.0	3,280.5	3,645.0

With the above table, I have calculated an estimation of Tesla's income statement from 2020 to 2023. Sales were projected by taking the actual sales numbers from 2019 and projecting forward. I took the actual number of $24 Billion in sales and then the projected change in Tesla

% change for 2020 + 100%, and multiplied them. The following years followed the same type of forecast: The previous year adding the projected growth for the current year on the income statement. Using this approach, by year 2023, Tesla would have expected sales of around $41 billion. I followed this pattern for every item on the income statement, making sure Gross Profit stayed consistent with the usual calculation, the difference between sales revenue and cost of goods sold. Once this was all projected, we can see signs that Tesla will really begin to come alive, as Gross Profit, EBITDA, and EBIT begin to improve each year and become overall positive numbers. If Tesla continues at this forecasted pace it would seem investors were right to trust in a company that, so far in its life, has been negative in nearly every overall income calculation.

Finally, with the knowledge that Tesla will only continue to become more profitable, we can see just how valuable their change in battery prices has been and will continue to be for the company. The below table shows the approximate number of sales that Tesla would have had in 2016. I assumed an average price of about $50,000 for a new Tesla, which is slightly above the price of the popular Model 3, but lower than the premium Model S. Taking this $50,000 per vehicle, I was able to divide the actual sales revenue in 2016 by this average price to get total number of vehicle sales.

	Average cost $50,000*		
	# of sales:	% of sales EV	# of EV Sales(Whole)
2016	140002.64	100%	140003.00
2019	491560.00	100%	491560.00
	kw/h assuming 60 per vehicle*	Total Cost:	Reverse scenario
2016	8400180	$ 3,953,684,720.00	$ 1,310,428,080.00
2019	29493600	$ 4,601,001,600.00	$ 13,881,654,400.00
	% saved in 2019:	66.86%	

Further, since Tesla only sells electric vehicles, the % of sales that are electric are 100%, meaning the next column, the whole number of EV sales for the company, would be the same as the % of vehicle sales in the left-hand column. The same held true for 2019 estimates of sales and EV specific sales. I took the 2019 sales revenue and divided by $50,000. Using this logic 2016 and 2019 would have had, respectively, 140,003 sales and 491,560 sales. This projection was actually not far off from reports that Tesla had sold over 367,500 vehicles in 2019, "on the low end of the estimate of 360,000 to 400,000" plus vehicles expected to sell.[15] This number in fact was larger than "the two previous years combined." Here we have proof that financial models, though sometimes way off expectation, can also be fairly close to the actual numbers they intend to forecast. Models don't just presume and foreshadow useless information, but numbers that often can be influential in decision making for big corporations.

With these two expected number of sales for 2016 and 2019, we were able to see about how many kWh of battery storage that Tesla needed to produce. Multiplying each number by 60, the average number of kWh in each Tesla PowerWall battery, we can find the approximate number for this. In 2016, Tesla would have created approximately 8.4 million kWh. By using the average cost per kWh in 2016 ($470.64 per kWh) I calculated previously, we can multiply this 8.4 million by the cost to see approximately how much Tesla would have spent in 2016 on batteries. The same holds true for 2019, except rather than the 2016 cost, we would use the cost / kWh of $156. Therefore, with 29.5 million kWh in 2019, the total price would have been

[15] O'Kane, Sean. "Tesla Sold More Cars in 2019 than in the Previous Two Years Combined." The Verge. The Verge, January 3, 2020. https://www.theverge.com/2020/1/3/21047233/tesla-2019-deliveries-q4-record-model-3-sales.

$4.6 billion, compared to 2016's cost of $3.95 billion. Looking specifically at these two numbers, we see almost four times the number of kWh's produced in 2019, yet only a slight increase in price. Working backwards, if in 2019 with the 29.5 kWh produced we used the 2016 cost, the total cost would be almost $14 Billion. Setting this up in a proportion, we see that Tesla would have saved nearly 67% from one year to the other. That is a ton of savings that we can visibly see!

Chapter 4: Nissan Analysis

Our next section will focus on performing the same type of analysis for Nissan, a company that manufactures both EV and ICE vehicles. There are a few changes with this analysis however, stemming from the kinds of vehicles that Nissan manufactures and sells. Currently, as mentioned before, one of the best-selling if not *the* best-selling electric vehicles on the market is the Nissan Leaf, which has been around since 2010. With the Nissan analysis it's necessary to look at Nissan through a percentage lens. Like Tesla, the more the world focuses on EV's, the more EV sales Nissan will have. Because Nissan currently sells the majority of their vehicles as internal combustible engines based off of gasoline consumption, it would seem likely that as the world adapts to EV's and they become more popular and mainstream, the percentage of sales that Nissan has for electric vehicles will also increase. So, whereas Tesla will always have 100% of their sales be from EV's, Nissan will see a drastic shift over the next half-decade.

Like was done with Tesla, the first step in my analysis of Nissan involved obtaining the financials since 2016. I obtained all the financials for Nissan through CapitalIQ, just like with Tesla, and compiled them into a condensed income statement that summarized the financials into the most important figures.[16] The below table shows the Sales, Cost of goods sold, Gross Profit, and other key financials that I will forecast into the future later in the analysis.

[16] "S&P Capital IQ." Accessed February 10, 2020. http://capitaliq.com/.

	12 months Mar-31-2016	12 months Mar-31-2017	12 months Mar-31-2018	12 months Mar-31-2019
Sales	99,898.9	96,294.3	101,707.6	93,643.3
COGS (incl. D&A)	81,711.9	78,647.9	85,092.9	79,874.3
Gross Profit	21,293.4	20,605.3	20,123.0	17,181.2
SG&A	13,220.8	12,682.7	13,341.8	13,053.5
R&D	-	-	-	-
EBIT	7,060.1	6,656.8	5,411.8	2,871.8
Interest Expense	(220.8)	(126.7)	(119.3)	(121.6)
Pre-tax Income	6,839.3	6,530.1	5,292.5	2,750.2
Income Taxes	1,603.2	2,373.4	(498.2)	1,225.5
Noncontrolling Interest	-			
Preferred Dividends	-	-	-	-
Net Income	4,662.2	5,950.7	7,032.6	2,880.0
Effective Tax Rate	24.6%	27.4%	N/A	28.4%
Weighted Avg. Diluted Shares	4,191.2	3,998.5	3,911.2	3,911.7
Diluted EPS	1.11	1.49	1.8	0.74
Depreciation & Amortization	401.0	455.4	507.8	502.5
EBITDA	10,887.1	10,186.9	9,079.1	6,363.0

In the table we see relatively constant, stable sales and COGS numbers that correlate with them. Clearly Nissan has productive Gross Profit numbers as well. Unlike Tesla however, Nissan has solid numbers in their EBIT and EBITDA columns. These are numbers that one would expect from a perennial Fortune 500 Company – numbers that don't inflate or deflate from year to year, but stay constant year over year. (We will, obviously, see a drastic decline in 2020 – this will be due to the Coronavirus pandemic that has devastated nearly every industry. Fear not,

Nissan will bounce back.) Earnings per share are also positive and stable numbers, meaning stock holders are rewarded for holding onto their investments yearly.

Like with Tesla, the next phase in the analysis was to look into the projected battery prices per year. Luckily this information stayed the same, and so holding onto this the next step was to, again, look at the average increase in percentage EV sales per year. Like was done previously, the assumption is that by 2025, 30% of new vehicle sales will be electric. JP Morgan assumed that in 2016, only 1% of vehicles sold were electric.[17] Taking this and the Tesla Effect discussed previously into effect, I assumed that 15% of all new car sales would be electric in 2019, increasing by 2.5% yearly. Unlike with Tesla, these numbers are all we would need for Nissan; whereas Tesla would need to see sales growth per year, I assume that Nissan simply switches from ICE to EV, and will maintain their sales per year.

Estimation of increase in sales assuming 15% in 2019 and the data from JPMorgan for 30 in 2025

1% of vehicles were electric in 2016*	
Average % Change per year:	2.5%
2019	15.0%
2020	17.5%
2021	20.0%
2022	22.5%
2023	25.0%
2024	27.5%
2025	30.0%

[17] J.P. Morgan, "Future of Electric Vehicles"

After computing these statistics, we would need to know the average number of kWh in a Nissan EV (presumably the Leaf discussed earlier) to find overall cash savings. Available public information suggests that the average Nissan Leaf currently comes equipped with a 30-kWh battery. The below table compares prices for a 2019 battery with 2016 batteries, and shows the savings that Nissan would have per vehicle with technology switching during this three year stretch.

Nissan Leaf is bestselling Nissan EV*		
Each Leaf has 30Kwh battery		
Battery Cost per vehicle in 2016:	$	14,120.00
Battery Cost per vehicle in 2019:	$	4,680.00
Overall Savings:	$	9,440.00

For 2016 the price was averaged at approximately $470 per kWh. (See calculations from Chapter 3.) Multiplying this by the standard 30 hours would yield a price of roughly $14,000. Comparatively, the price from the same table in 2019 would be $156 per kWh, a number reported by Bloomberg.[18] This number multiplied by 30 would give an average cost of approximately $4,700 per battery. Taking the difference between the two, we can see that Nissan would save $9,440 per each vehicle they made, just looking at the change in battery cost.

The next section of my analysis consists of using this information and seeing the savings spread from, like Tesla, 2016 to 2019.

[18] BNef, "Battery Pack Prices Fall As Market Ramps Up"

	# of sales:	% of sales EV	# of EV Sales
2016	4994946.82	1%	49950.00
2019	4682166.63	15%	702325.00
	kw/h assuming 30 per vehicle*	Total Cost:	Reverse scenario
2016	1498500	$ 705,294,000.00	$ 233,766,000.00
2019	21069750.00	$ 3,286,881,000.00	$ 9,916,829,000.00
	% saved in 2019:	66.86%	

As the table above, very similar to the Tesla table in the previous chapter shows, there will be a lot of cash saved between 2016 production vs. 2019 production. To find the numbers of total vehicle sold, I took the original income statement numbers for sales revenue and divided by an average price of $30,000. Nissan does have some lower-end vehicles, but also offer expensive luxury cars and high-priced SUV's. With all of these averaged, $30,000 seems to be a fair estimate for the average cost of a Nissan vehicle. Dividing the 2016 income statement sales revenue by 30,000, I found that Nissan would have sold approximately 4.99 million vehicles in 2016. For the actual reported fiscal year sales, "Nissan [reported] global unit sales [of] 5.63 million units."[19] This, like with Tesla, is very close to our 2016 estimate.

With the 1% of projected vehicles sold being electric in 2016 (given to us by JPMorgan)[20], we can take 1% of the total sales and come up with an estimated 49,950 electric vehicles sales for Nissan in 2016. With 2019 I did the same calculations – I went back to the

[19] "Nissan Reports Full-Year Results for Fiscal Year 2016." Nissan News USA, March 21, 2019. https://usa.nissannews.com/en-US/releases/release-41b74338d538442e8bc6878152145c3b-nissan-reports-full-year-results-for-fiscal-year-2016.

[20] J.P. Morgan, "Future of Electric Vehicles"

original Income Statement, took the 2019 reported sales revenue from it, and divided this number by 30,000. This yielded a slightly less projected number of total sales for 2019, approximately 4.7 million units. With the projected vehicles sold being electric at 15% of the total sales, I found an estimate of 702,325 electric units sold in 2019.

With the assumption that every Nissan EV has a 30kWh battery attached, in order to find the total number of produced kWh, I simply multiplied the total sales of 2016 by 30. In 2016 the assumed cost per kWh was $470.67. Multiplying the total kWh by this cost per kWh, I arrived at an estimated cost on batteries in 2016 to be $705 million. Using the same calculations for the year 2019, an estimated 702,325 vehicles would need over 21 million kWh. Luckily, the battery price was much cheaper in 2019! Multiplying this number by the much lower cost of $156 per kWh, the total cost for batteries in 2019 would have been $3.286 billion. Though this number seems to be astronomically higher than the 2016 estimation of $705 million, there are approximately 15 times the amount of EV sales in 2019 vs. 2016. If we assumed that the cost per kWh in 2019 was the same as 2016, $470.67, the total cost would be $9.9 billion. Like with Tesla, we see an approximate savings of 67%!

With this cost savings completed, the final part of the analysis is assuming past numbers and projecting future EV-only sales for Nissan.

EV Only Income Statement	2016	2019	2022	2025
Sales	$ 998.99	$ 14,046.50	$ 22,024.36	$ 29,365.81
COGS (incl. D&A)	$ 817.12	$ 11,981.14	$ 18,299.64	$ 24,399.52
Gross Profit	$ 212.93	$ 2,577.17	$ 4,455.16	$ 5,940.21
SG&A	$ 132.21	$ 1,958.03	$ 2,941.81	$ 3,922.41
R&D				
EBIT	$ 70.60	$ 430.77	$ 1,237.53	$ 1,650.04
Interest Expense	$ (2.21)	$ (18.24)	$ (33.10)	$ (44.13)
Pre-tax Income	$ 68.39	$ 412.53	$ 1,204.43	$ 1,605.91
Income Taxes	$ 16.03	$ 183.82	$ 264.60	$ 352.80
Noncontrolling Interest				
Preferred Dividends				
Net Income	$ 46.62	$ 432.01	$ 1,154.56	$ 1,539.41
*Averaging out from 2016 - 2019 for 2022 and 2025				

I wanted to look at what the projected sales numbers would be assuming the 1% of vehicles statistic for 2016. Multiplying the original income statement sales revenue by .01, I found Nissan's sales from EV's in 2016 would have been approximately $999 million. The rest of the key numbers were also calculated the same way; multiplying their original amount by 1%. Moving to 2019, the percentage is estimated at 15%. Therefore, I took the original numbers from 2019 and multiplied them by 15%. We see a huge jump in every category, but it's important to remember that these numbers correlate with a loss in percentage of regular gasoline-based vehicle sales. Further, for 2022 and 2025, I first took the average of the sales numbers from the original income statement, due to the fact that Nissan is a mature, stable company. I then multiplied this amount by the correlating projected percentage; 22.5% in 2022 and the estimated 30% statistic given by JP Morgan in 2025. The other key income statement results for years 2022 and 2025 followed an identical trend. I took the average of their

reciprocal in the original income statement and multiplied by the correlating percentage of vehicles to be sold that were projected to be electric.

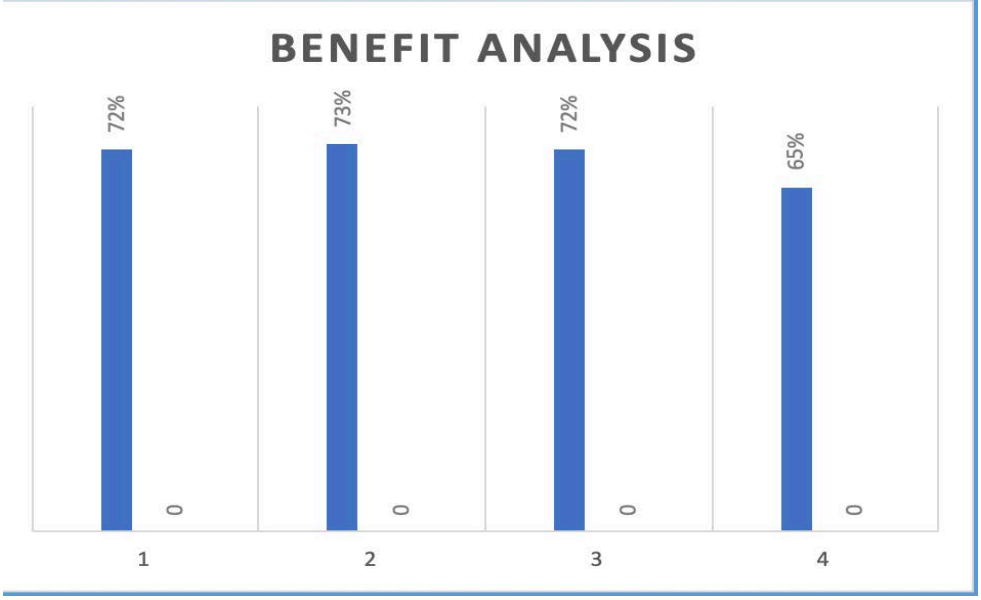
Chapter 5: Overall Analysis and Survey

With all of this information complete, finally we need to know what it means. The basic reason for this analysis was to show how decreasing battery prices save companies massive amounts of money. These savings allow the companies to create more attractive vehicles to be available to the public. How many people switch to electric depends on prices of these vehicles and the updates and benefits that manufacturers can provide with them. As the percentage of vehicles based off of electric batteries rises, so too does the amount of the company's finances dependent on EV sales. We see that with Tesla, their overall sales will continue to grow. However, with Nissan, they will need to adapt and become more reliant on EV production. As the price for these batteries decreases, automobile companies such as Tesla and Nissan can do one of two things; they can make the vehicles cheaper for consumers, or they can take these savings and make the vehicles better for the same price (mainly focusing on battery range and miles per kWh updates). Either of these two options would seem to make the vehicles more desirable to the public. A cheaper price point makes the vehicles more viable for every price range of consumer, while updates mean that the vehicles provide more value for their dollar cost. In the end, both the company and the consumer turn out to benefit.

Clearly, we can tell that EV's are making strides, and soon the market will be more electric-centric. A question, in the meanwhile, is how many people want to buy these vehicles currently, and do average consumers know the benefits that EV's can offer. A recent survey completed by the Consumer Reports and Union of Concerned Scientists in the middle of 2019

suggests that the average consumer can perceive great value from going electric.[21] This 2019 survey was based on a random population sample of 1,659 American adults. Each of these surveyed adults were looking into buying a vehicle in the following two weeks. Knowing this, we can assume that the survey was given in an intro or exit interview into an automobile dealership's offices. The table below shows the percentage of the population that figured they would benefit from different kinds of available EV's, reducing their use of oil, reducing their pollution, and saving money on fuel. The results range from 65% to 73% in each of the four categories.

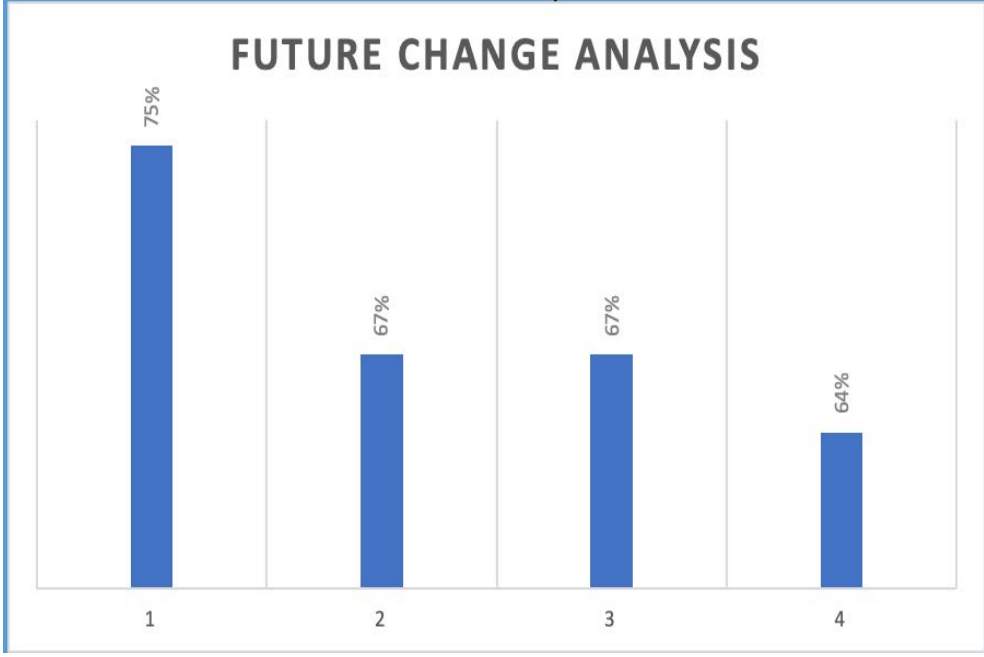
Automakers should provide more kinds of EV's	1
EV use will help reduce use of oil	2
Increased EV use will reduce pollution	3
EV's will help save money on fuel and maintenance	4



[21] "New Survey Shows Strong Support for Electric Vehicles Across Economic Spectrum." Union of Concerned Scientists. Accessed May 5, 2020. https://www.ucsusa.org/about/news/survey-shows-strong-support-electric-vehicles.

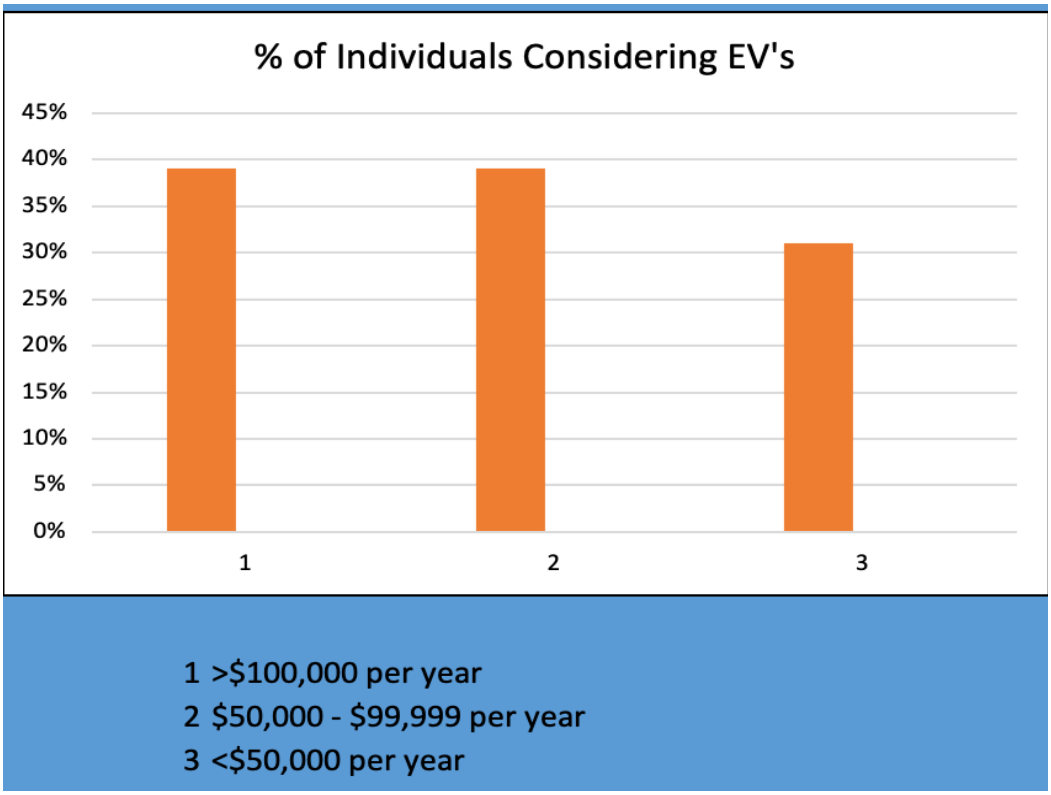
Another part of the survey is shown in a table below, this time focusing on future changes that the surveyed population would like to see. The changes included both incentives and tax rebates for all consumers and discount rates on electricity used for charging EV's. It also included whether states should invest in EV charging stations, and also whether they should increase public transportation reliant on EV's. Like the previous table, the questions received high marks. 64 to 75% of the surveyed population agreed with these four changes.

Incentives and tax rabates for EV's should be available to all consumers	1
Electric companies should offer discount rates for EV charging	2
State should invest in EV charging stations	3
State should increase EV school busses and public transit busses	4



Lastly, the survey asked the population if they were actively considering purchasing an EV as their next vehicle, and what their reported income range was. This table below shows three income ranges, those making less than $50,000 per year, those making between $50 -100,000 per year, and those making above $100,000 per year. The results did not seem to differ very

much from bracket to bracket, as the highest two income ranges both scored a 39% and the lowest range a 31% of future car buyers that could realistically purchase an EV in the following two weeks.



In conclusion, this survey not only affirms but also strengthens the argument that EV's are the future of transportation. While Governments and companies around the world each shape how quickly the conversion to an electric society will occur, new technology in the creation and ranges of batteries allow for better and cheaper vehicle prices. As shown in the analysis of both a complete Electric Vehicle company and an originally gasoline-based company now in between both forms, we see how these cheaper and more advanced vehicles offer a win-win for both company and consumer. While there may be growing pains, and some titans of the industry could fall as new companies rise to unexpected heights, the hope is that the

switching to electric reduces pollution and makes an impact. There will be winners and losers all around us, but the primary concern is that the environment can be the overwhelming champion.

Bibliography:

"About EV Charging." Electrify America. Accessed May 5, 2020. https://www.electrifyamerica.com/about-ev-charging.

"Battery Pack Prices Fall As Market Ramps Up With Market Average At $156/KWh In 2019." BloombergNEF, December 3, 2019. https://about.bnef.com/blog/battery-pack-prices-fall-as-market-ramps-up-with-market-average-at-156-kwh-in-2019/.

"BU-1003: Electric Vehicle (EV)." BU-1003: Electric Vehicle (EV) – Battery University. Accessed May 5, 2020. https://batteryuniversity.com/learn/article/electric_vehicle_ev.

"Driving into 2025: The Future of Electric Vehicles: J.P. Morgan." Driving into 2025: The Future of Electric Vehicles | J.P. Morgan. Accessed May 5, 2020. https://www.jpmorgan.com/global/research/electric-vehicles.

Francis, Sam. "Top 20 Electric Vehicle Charging Station Companies." Robotics & Automation News, November 27, 2019. https://roboticsandautomationnews.com/2019/05/01/top-20-electric-vehicle-charging-station-companies/22138/.

Hayes, Adam. "The Economics of Tesla Batteries." Investopedia. Investopedia, January 29, 2020. https://www.investopedia.com/articles/investing/050715/economics-tesla-batteries.asp.

MarketScreener. "NISSAN MOTOR CO., LTD. : Financial Data Forecasts Estimates and Expectations: 7201: JP3672400003: MarketScreener." MarketScreener.com | stock exchange quotes| Company News. Accessed May 5, 2020. https://www.marketscreener.com/NISSAN-MOTOR-CO-LTD-6492477/financials/.

"New Survey Shows Strong Support for Electric Vehicles Across Economic Spectrum." Union of Concerned Scientists. Accessed May 5, 2020. https://www.ucsusa.org/about/news/survey-shows-strong-support-electric-vehicles.

"Nissan Leaf." Wikipedia. Wikimedia Foundation, May 2, 2020. https://en.wikipedia.org/wiki/Nissan_Leaf#First_generation_(2010–2017).

"Nissan Leaf." Wikipedia. Wikimedia Foundation, May 2, 2020. https://en.wikipedia.org/wiki/Nissan_Leaf.

"Nissan Reports Full-Year Results for Fiscal Year 2016." Nissan News USA, March 21, 2019. https://usa.nissannews.com/en-US/releases/release-41b74338d538442e8bc6878152145c3b-nissan-reports-full-year-results-for-fiscal-year-2016.

O'Kane, Sean. "NIO's New SUV Can't Save the Company from Its Current Problems." The Verge. The Verge, December 30, 2019. https://www.theverge.com/2019/12/30/21043027/nio-ec6-suv-q3-finances-earnings-cash-fundraising.

O'Kane, Sean. "Tesla Sold More Cars in 2019 than in the Previous Two Years Combined." The Verge. The Verge, January 3, 2020. https://www.theverge.com/2020/1/3/21047233/tesla-2019-deliveries-q4-record-model-3-sales.

Research, Car and Driver. "What Is an Electric Vehicle Tax Credit?" Car and Driver. Car and Driver, March 22, 2020. https://www.caranddriver.com/research/a31267893/electric-vehicle-tax-credit/.

Richardson, Luke. “How Much Does a Tesla Cost in 2020? [Updated Prices]: EnergySage.” Solar News. EnergySage, July 25, 2019. https://news.energysage.com/how-much-does-a-tesla-cost/.

“S&P Capital IQ.” Accessed February 10, 2020. http://capitaliq.com/.

“Tesla Q4 2019 Vehicle Production & Deliveries.” Tesla, Inc. Accessed May 5, 2020. https://ir.tesla.com/news-releases/news-release-details/tesla-q4-2019-vehicle-production-deliveries.

“The End of Fossil Fuels.” Ecotricity. Accessed May 5, 2020. https://www.ecotricity.co.uk/our-green-energy/energy-independence/the-end-of-fossil-fuels.

“Capital One Credit Cards, Bank, and Loans” - Personal and Business. Accessed May 5, 2020. https://www.capitalone.com/cars/learn/finding-the-right-car/the-tesla-effect-how-tesla-is-changing-the-used-car-game/1096.[22]