University of Nevada, Reno

Cost-Benefit Analysis of the Integration of Electric Semi Trucks to the Walmart Distribution Network within the United States

A thesis submitted in partial fulfillment

of the requirements for the degree of

Bachelor of Science in Business Administration in Accounting, Finance, and the Honors Program

by

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May 8, 2019

UNIVERSITY

OF NEVADA

RENO

THE HONORS PROGRAM

We recommend that the thesis

prepared under our supervision by

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Entitled

A Cost-Benefit Analysis of the Integration of Electric Semi Trucks to the Walmart Distribution Network within the United States

be accepted in partial fulfillment of the

requirements for the degree of

BACHELOR OF SCIENCE IN BUSINESS ADMINISTRATION, FINANCE AND ACCOUNTING

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May 8, 2019

Abstract

Global warming is caused by greenhouse gasses blanketing and warming the earth. The UN has issued a special report saying that if global warming is not mitigated to 1.5 Celsius then there could be severe consequences including: flora and fauna extinction, coastal flooding, and severe droughts (un.org). Businesses and consumers are consistently become more environmentally aware, especially among younger generations. When cost-efficient, corporations will make adjustments within their business model to improve sustainability to capture more market share while additionally working to allow for their continue to be a positive future for younger generations.

Walmart is an example of a company that has prioritized the customer by developing an incredibly cost-efficient supply chain that results in the customer receiving the best price. Current government subsidies and advances in electric vehicles have allowed for market opportunities to arise for Walmart to potentially make vast improvements within their distribution model. The market opportunity is to buy Tesla electric semi-trucks, charge them by using a Tesla Megacharger, and power them by either grid electricity or energy created by solar panels. This project results in a net present value of money saved of approximately $11,000,000 and $5,000,000 over a span of 30 years. This would also secure more fixed costs than variable costs because transportation prices would not rise with diesel. There are numerous challenges related to the adoption of an entirely new system, but with an approximate saving of 2,481,960 tons of CO2 by 2050, my study attempts to address and quantify various benefits and negatives associated with the change in systems.

Acknowledgements

I'd like to thank the University of Nevada, Reno for providing me with a superb undergraduate education that has helped land me a job working at jet.com (a subsidiary of Walmart E-Commerce). I would never have written this paper or experienced any level of success without the numerous authors and story tellers I have never met, but will always look up to, so I am thankful for them. I would also like to thank my thesis advisor, Mark Pingle, for being patient and supportive with everything related to this thesis. I would like to thank every professor or mentor I have had who has answered one of my numerous questions that I have asked throughout the course of my formal and informal education. Lastly, I would like to thank everyone who has continued to pursue knowledge and contribute to making the world a better place than they found it, these people are the ones that drive me to make a lasting contribution to society so they will continue to have the means to thrive and innovate.

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Introduction

Battery technology as reached a point, according to the Tesla website, that there is now a viable alternative to internal combustion vehicles for the short distance freight transportation industry (tesla.com). This is very important because the world is at a tipping point of for Global Warming, and businesses must soon start making large changes to curve the worst impacts. Ideally a large company that plans on instituting environmentally conscious initiatives would be the best candidate to do something to have the largest impact without there being a government declaring a systematic change which would not be supported in a free market economy.

Founded in 1962, Walmart has grown to be the largest retailer in the world, largest company by revenue in the world and the third largest employer in the world, second to only the United States Department of Defense and the People's Liberation Army of China (Fortune). They were able to reach this scale by executing the strategy of Everyday low prices (EDLP) to customers by building extreme economies of scale and by building an extremely efficient supply chain. To accomplish this they currently have 157 distribution centers within the US where close to 78% of inventory is held before arriving at the store (Walmart Inc. 8). Each one of these distribution centers is an average of 150 miles away from the stores they service. To move the massive amount of inventory that is necessary to accumulate $318.5 billion in net sales, Walmart transports nearly all of its own goods, with the exception of perishable foods, by utilizing the 3rd largest private truck fleet in the US consisting of approximately 6,100 semi-trucks.

In addition to having a strategy of cutting costs and lowering prices through optimizing supply chain, Walmart has also drawn more importance to sustainability within operations by initiating “Project Gigaton” in 2017. Project Gigaton’s purpose is to reduce CO2 emissions throughout the supply chain, including suppliers, by one billion metric tons by the year 2030. To accomplish this project, one of Walmart’s main focuses is making their fleet as efficient as possible. From 2005 to 2015 they increase fleet efficiency by 85% by minimizing truck idle times, optimizing truck route, and by utilizing technology to maximize fuel efficiency. While these efforts have been substantial in mitigating carbon emissions and money spent on fuel, Walmart must continue to take bold risks in the name of saving money and minimizing their Carbon Footprint. A possibly great opportunity to accomplish both these ends would be to integrate electric semi-trucks produced by Tesla into their distribution network. Tesla announced their semi-truck in 2017 and is slated to have these vehicles go into production in 2019. The trucks are supposed to have a range of 300 -500 miles depending on the model, sell for a price $150,000 or $180,000 depending on the model, and will have a battery of a megawatt. Walmart has already placed an order for 30 trucks for a Canadian distribution center. To support these trucks, Tesla has announced they are soon going to put out a Megacharger, capable of charging a semi to 80% of its full range within 30 minutes. A Walmart distribution center could potentially have these Megachargers built on site to have trucks charged at their facility instead of having to go to a gas station. To further maximize cost savings and mitigate greenhouse gas emissions dependent on the energy source of the local power grid, it would also be possible to install solar panels on the roof of a distribution center and charge the trucks from energy generated from the solar panels. To determine if this project would be feasible from a cost standpoint, it would be necessary to determine how many trucks an average distribution center could charge and then to determine the net present value (NPV) of all the cash inflows and outflows of normal Freightliner Cascadia trucks powered by diesel in comparison to electric trucks charged by energy created from solar panels or from grid electricity.

After doing cost projections over a period of 30 years, this project will provide a net profit of $5,109,390.32 and will pay itself off in 6.26 years based on inputs from the state of California.

Literature Review

To understand the societal and technological challenges related to replacing internal combustion engines (ICV's) with electric vehicles (EV's) for a portion of a company's trucking fleet, it is first imperative to understand why internal combustion vehicles became the dominant player within the personal transportation market to begin with. When automobiles, originally called horseless carriages, were first introduced to America in 1895, there were three engine options that shared the market, which consisted of steam powered, gas powered, and electricity powered (Loeb 2). This is evident based on the car registration details from New York in 1903, where among the 4000 registered motor vehicles, 53% were steam powered, 27% were gasoline powered, and 20% were electricity powered (Hoyer). These three types of automobiles were all aesthetically very similar; however, they functioned vastly different from one another, which makes them incomparable to current market segmentation between different models of internal combustion vehicles which all have relatively similar engines. The mostly equal market distribution apparent in 1903 did not last, and within 1904, 18,699 of 21,692 automobiles sold were internal combustion vehicles, and internal combustion vehicles have been the dominant player within this market ever since (Flink 234).

To understand how the internal combustion vehicles came to be as dominant as it currently is, the other two competitor's strong and weak points must first be expanded upon. The steam powered car was able to establish early dominance within the market because the steam engine, invented by James Watt 1768, had the most prior knowledge accumulated on it due to the high utilization of a similar engine type on steam boats and locomotives (Polvo 326). An example of this early success is evident from the Stanley Locomobiles being the highest selling car in 1900 and 1901 (Villalon and Laux 65-82). The Locomobile was able to achieve market domination because the Stanley's marketed the virtues of their car including quiet and comfortable driving in comparison to internal combustion vehicles (Leob 4). Despite similar engines existing for steamboats and locomotives, the common man did not share this technical knowledge, and to run a steam powered car from this time period the owner had to know how to read and adjust gauges otherwise too much pressure would build up, and there was a well-documented instance of a steam car's boiler exploding in a 1901 Detroit auto show which resulted in a lot of bad publicity for steam cars (Leob 6). In addition to safety hazards, steam powered cars also were reliant on a constant supply of water without minerals to be used in the boiler tank, and on longer drives, there was not always water readily available for how often the car needed to be filled up. This continuous use of water was not an issue in the Northeast where there was always a city within close proximity, but this need for water disqualified steam cars from being a good candidate to drive cross country with (Leob 6). Lastly steam cars were also at a disadvantage because they took up to 30 minutes for the boiler to warm up enough to drive the car, and if there was freezing weather outside the car may have been unusable all together (Leob 6).

To understand why internal combustion vehicles were able to gain dominance so quickly, Alan Loeb conducts a framework comparing steam, electric, and gas powered vehicles within *Steam Versus Electric Versus Internal Combustion Choosing Vehicle Technology at the Start of the Automotive Age.* Loeb examines how internal combustion vehicles were able to establish dominance from 1900 – 1903 because this was prior to

Henry Ford mass producing the Model T making internal combustion vehicles unbeatable on price. Within Table 1, Loeb breaks down relative competitive advantages by car type.

Table 1 Automotive Virtues, by Vehicle Type (1900-1903) (Loeb)

Virtues	Electric	Steam	Internal Combustion
clean, free of smoke and odor	yes	no	no
quiet	yes	yes	no
safe, low cost of insurance	yes	no	no
reliable, few repairs, durable	yes/limited	no	no
simple, easy to maintain	yes	yes	no
easy to drive and control	yes	no	no
free of vibration	yes	yes	no
instant starting	yes	no	no
elegant, refined	yes	various	various
economical to buy	no	no	no
economical to operate	no	no	no
luxury and status of ownership	yes	yes	yes
speed, acceleration	no/limited	yes	yes
power	no	yes	yes
range, distance	no	no/limited	yes
infrastructure	no	yes (fuel), no (water)	yes

After the previously level playing field, gasoline powered cars were able to gain near total market share throughout the first quarter of the century due to their low cost, ease of use, and connotations surrounding ownership of steam and electric powered vehicles (Loeb 9). The electric car had positives including producing less fumes and making less noise, however, its range was limited by the battery it was equipped with. The main reason people wanted cars was for touring, with charging limitations in every part of the country besides the Northeast, electric vehicles were not able to hold on to nearly any market share throughout the 1900's, and the internal combustion vehicle was able to become the dominant player that it is today. The internal combustion vehicle was very strong in its use for the consumer, however, it very negatively impacted the overall environment.

The overall environment is important when looking at all of the impacts of what a company does. In *What Conscious Capitalism Really Is*, John Mackey writes a response to James O'Toole and David Vogel's *Two and a Half Cheers for Conscious Capitalism* where Mackey defends himself from the criticisms O'Toole and Vogel made of Mackey's book *Conscious Capitalism.* The most important definition Mackey elaborates upon in relation to my thesis is what it means to be a stakeholder, a stakeholder in accordance with Conscious Capitalism includes: customers, employees, suppliers, investors, society, and the environment (Mackey 84). Under Conscious Capitalism, stakeholders operate in a way so that they can most often get win-win scenarios and are constantly working towards creating the most value for each other. It is important to note that not all stakeholders are given equal importance, because if the business is not financially healthy, it cannot continue to operate. Despite this a strong company will work out solutions that will come to benefit all stakeholders in some way.

The environment is a stakeholder that is worth paying a great deal of attention to because if the natural world stops providing as many resources as we currently take from it then it does not matter how much profits that businesses make. Global warming is a huge threat to the environment, and it is projected to start causing severe droughts throughout the world. Benjamin Cook, Jason Smerdon, Richard Saeger, and Sloan Coats creating a model projecting how precipitation would be affected by area dependent on the severity of the impacts of Global Warming. They projected that it would hit regions that are already arid the hardest. They analyzed this in a way to look at long-term trends opposed to yearly totals.

Global warming has been occurring since the last ice age. Global warming caused by humans, however, has been occurring since the mid-20th century (NASA). Human influences on global warming on primarily greenhouse gasses. These gasses include nitrous oxide, water vapor, carbon dioxide, and methane. The IPCC notes that a primary driver of this is transportation and the gasses put into the atmosphere by burning fossil fuels. If we aggressively mitigate future output of these gasses so that our output is net zero soon, the worst side effects of climate change can be avoided (IPCC). There is a huge opportunity to reduce emissions by simply changing how we operate our transportation systems. The Center for Biological Diversity notes that as much as 15% of all carbon dioxide is produced by travel, there have been several government actions to reduce this, namely the Clean Air Act, but there must be continued action within the private sector if these emissions are to be reduced by a meaningful amount.

Methodology

This project examines the feasibility of substituting part of Walmart's current truck fleet consisting of Freightliner Cascadias conventional diesel freight trucks with two alternative methods of delivery including: switching to Tesla Semi Trucks charged by Tesla Mega Chargers powered by solar panels or to switching to Tesla Semi Trucks charged by Tesla Mega Chargers powered by electricity from the grid. Walmart has the third largest private shipping fleet in the United States, and except for perishable groceries, the fleet completes nearly all of the shipping from distribution centers to Walmart stores. I built an Excel model to analyze the Net Present Value, Payback Period, and Projected Tons of Carbon Emission saved in order to judge whether switching to Tesla Semi trucks powered off of either the electric grid or solar panels warrants the effort of adopting a new process with the Walmart distribution network. The main indicators as to whether or not either version of this project is worth implementing are whether there is a positive Net Present Value of this project and also how much carbon emissions are saved to contribute towards meeting Walmart's Corporate Social Responsibility goal of reducing emissions throughout their supply chain by one billion metric tons of carbon per year by 2030.

To give an overview of the variables used within this project before going into detail about the relevance, methodology, and application, tables 2 through 4 have all the different variables utilized for the three different projects.

Table 2. Cascadia Cost Inputs

Variable	Input
MPG Diesel	7.25
CA Diesel Price	$ 3.97
Miles Driven	100000
Number of Trucks	74
% Salvage Value	0.25
WACC	0.1
Cascadia Cost	$ 145,900.00
CO2 per gallon	22.38
Tax RT	0.32

Table 3. Solar Powered Tesla Cost Inputs

Variable	Input
Solar Panel Cost	$ 20,458,183.15
MegaChargers Needed	2.00
Mega Charger Cost	$ 2,000,000.00
Tax Credit	30%
Tesla Truck Cost	$ 200,000.00
Miles Driven	100000
Number of Trucks	74
*RT inflation	0.015
Tax RT	0.32
% Salvage Value	0.25
WACC	0.1

Table 4. Electric Grid Powered Tesla Cost Input

Variable	Input
Number of Trucks	74
Mega Chargers Needed	3
KWH per mile	2
Cost per KWH	$ 0.0693
electricity cost per mile	$ 0.1386
Miles Driven	100000
Tesla Cost	$ 200,000.00
*RT inflation	0.015
Tax RT	0.32
WACC	0.1
% Salvage Value	0.25
Mega Charger Cost	2000000
MegaCharger Needed	2

To determine the number of trucks that would be used for this model, I looked at the maximum number of trucks that could systematically be supported from electricity generated from solar panels on the roof of a 1.3 million square foot distribution center based in Southern California. To calculate this number, I took an average of three 1000 kilowatt hour (kWh) systems found for sale online, looked at how much electricity they were projected to generate within the state of California, looked at how much square footage they required, and then looked at how many 1000 kWh systems could potentially be installed on the roof of the distribution center. I used 1000 kWh systems because they were the largest system where there was a reliable sample size to base estimates from. I pulled my information from solarelectricsupply.com I used this projection style to estimate generated electricity and generated price because different solar panels have different efficiency of capturing energy, and I wanted to ensure that the energy generation estimate matched the cost estimate. The length of this model is 30 years because that is the current estimated life of solar panels (energysage.com).

Table 5 Cost of Solar Panel System (solarelectricsupply.com)

System	50 KW	75 KW	100 KW	250 KW	500 KW	1,000 KW
Trina, Peimar or Axitec	$56,350 3,526 sq. ft.	$83,055 5,288 sq. ft.	$109,760 7,051 sq. ft.	$271,600 17,628 sq. ft.	$526,400 35,256 sq. ft.	$996,800 70,513 sq. ft.
REC, Silfab, Canadian Solar	$56,350 3,274 sq. ft.	$83,055 4,911 sq. ft.	$109,760 6,548 sq. ft.	$271,600 16,369 sq. ft.	$526,400 32,738 sq. ft.	$1,030,400 65,476 sq. ft.
LG, Hyundai, Mission Solar	$64,975 3,342 sq. ft.	$95,767 5,013 sq. ft.	$126,560 6,684 sq. ft.	$313,600 16,710 sq. ft.	$582,400 33,420 sq. ft.	$1,108,800 66,840 sq. ft.

Table 6 Solar Panel Output Summary

Variable	Input
Average Cost per 1000 kWh System	1,045,333.33
Average Sq ft per 1000 kWh System	67,609.67
Building Square Footage	1,300,000.00
Available Systems	19.23
Total Solar Panel Cost	20,099,689.89
Electricity Generated per peak hour	19,228.02
Average Los Angels Peak Hours	5.60
Electricity Generated Daily	107,676.91
Max Capacity Trucks Charged	107.68

The distribution center's location within Southern California is significant because I used California Diesel prices within my model, used California's cost per kWH for off the grid electricity, and used California's electricity efficiency for solar panels. California was chosen as the place for the potential adoption of this project because if this project were to be feasible anywhere, it would be most likely to be feasible where there are favorable conditions such as Southern California. Within the solar panel output summary, the max truck capacity is roughly 40% higher because I wanted to give large room for error within Tesla's Megacharger units for time spent charging.

Tesla has made very aggressive claims in regard to their proposed Megacharger. In a summary of a Tesla conference held in 2017, Fred Lamber of Electrek.com said, "Tesla says that it can add 400 miles of range to the Tesla Semi in 30 minutes. We expect it could mean an insane charge rate as high as 1.6 MW. During the presentation, Musk referenced the fact that 30 minutes is about the time it would take unload and load a truck, which means that it wouldn't lose any time if the chargers are installed at the destination.". To project the cost of installing a Tesla Megacharger, which have not been released yet, I took the current price a Tesla Megacharger estimated to be between $100,000 and $300,000 and multiplied that by the projected rate in charging improvements to get an average cost of $2,000,000 (Etherington). This is potentially the largest flaw in my model, but there are very little public resources to estimate the cost of a charger. Therefore I have overcompensated with the variable of trucks used in comparison to projected capacity of trucks charged to attempt to compensate for this flaw. In addition to compensating with projected costs, I have intentionally set my capacity at 74 trucks despite there theoretically being slightly under 96 trucks being made to charge per day with two Megachargers averaging 30-minute turnaround times a piece. I purposely did this to allow for room for error on Tesla estimates. Tesla Superchargers are estimated to have a useful life of 12 years, so for simplicity, I estimated them to have a life of 15 years, so new Megachargers would have to be bought twice throughout the 30-year cycle, and they have no resell value.

The trucks in all three models are depreciated using Modified Accelerated Cost Recovery System (MACRS) to track cast outflows. Both the Tesla and Cascadia trucks are fully depreciated over a five-year span. At the end of five years, they are sold at 25% of their purchase value based on estimates from looking at truck resells online, this accounts for my salvage value number of 25% referenced within my previous tables. Megachargers and trucks purchased later within my model cost more than the same items bought today because all capital expenditures are adjusted for yearly inflation of 1.5%.

Walmart's WACC was pulled from Marketwatch.com in order to analyze net present value to see if the project has a high enough return to pass the hurdle rate. If the NPV is positive this means the project should be approved. NPV calculates whether the project has a higher earning percentage than the Weighted Average Cost of Capital. This is important because it implies whether or not a company saves money at a higher percentage than their effective rate of interest.

Lastly the 30% number within my model used for tax credit is pulled from energy.gov. This number is very significant because it can cover a large portion of the cost of setting up a solar panel system, however, the plan is being phased out over the next couple of years, so to adjust by year for cost savings please edit the attached excel file. Solar panels will be subsidized 30% if installed prior to end of year 2019, will be subsidized 26% if installed during 2020, will be 22% subsidized if installed between 2020 and 2021 (energy.gov). These tax breaks are liable to change depending on acts of congress, and there also might be additional municipal and state incentives depending on the locality of the project.

Within my model I had revenue by truck to illustrate cash flows garnered by the trucks. This revenue was calculated by dividing Walmart's total US revenue by the 6,100 trucks that they own. In the comparison of different methods, the revenues generated is a moot point because it is the same across different models.

Results

From the results, I recommend both projects in comparison to using Cascadia Diesel trucks. Both projects have positive NPV's meaning that they will both make money faster than rate of inflation at a rate higher than the hurdle rate in comparison to continuing to use trucks that are subject to the price fluctuations of diesel. Most importantly, even with electric vehicles requiring 50% more greenhouse emissions to produce compared to normal trucks, 15 tons of CO2 to 10 tons of CO2 respectively, this project will save a projected 2,481,960 tons of CO2 by 2050. This will result in annual savings of 87,732 tons of CO2. This accounts for .0017% of annual US production and if this program was expanded from 1.3% of Walmart's fleet to include Walmart's whole fleet, this would save .1273% of annual US production.

Table 7 NPV Comparison

	Cascadia to Tesla Grid
NPV	$ 10,491,317.82
Payback Period	4.29
	Cascadia to Solar with inflation in diesel prices
NPV	$ 5,306,427.25
payback period	6.58

Table 8 Cascadia Versus Grid Tesla Cash Flows

Year	**Cascadia**	**Grid Energy**	Delta
2019	$ (10,796,600.00)	(18,800,000.00)	(8,003,400.00)
2020	$ 1,721,019,007.22	1,723,416,494.54	2,397,487.32
2021	$ 1,771,096,731.04	1,773,525,057.40	2,428,326.37
2022	$ 1,822,630,466.07	1,825,090,094.06	2,459,628.00
2023	$ 1,875,662,520.11	1,878,153,919.27	2,491,399.15
2024	$ 1,920,440,847.48	1,919,332,273.57	(1,108,573.91)
2025	$ 1,986,450,398.90	1,989,026,578.74	2,576,179.84
2026	$ 2,044,243,726.01	2,046,853,128.26	2,609,402.25
2027	$ 2,103,717,255.18	2,106,360,378.17	2,643,122.99
2028	$ 2,164,919,806.49	2,167,597,156.05	2,677,349.55
2029	$ 2,217,348,993.84	2,216,148,150.00	(1,200,843.84)
2030	$ 2,292,771,916.63	2,295,540,599.06	2,768,682.43
2031	$ 2,359,468,843.10	2,362,273,315.50	2,804,472.40
2032	$ 2,428,104,671.00	2,430,945,470.23	2,840,799.22
2033	$ 2,498,735,734.96	2,501,613,405.90	2,877,670.94
2034	$ 2,560,051,832.55	2,553,750,659.53	(6,301,173.02)
2035	$ 2,646,279,113.80	2,649,276,529.32	2,997,415.53
2036	$ 2,723,250,496.07	2,726,286,467.56	3,035,971.49
2037	$ 2,802,459,298.51	2,805,534,404.31	3,075,105.79
2038	$ 2,883,970,526.75	2,887,085,353.86	3,114,827.11
2039	$ 2,955,604,323.22	2,954,218,348.58	(1,385,974.64)
2040	$ 3,054,236,543.47	3,057,457,366.11	3,220,822.64
2041	$ 3,143,064,240.26	3,146,326,598.63	3,262,358.37
2042	$ 3,234,473,823.44	3,237,778,340.56	3,304,517.12
2043	$ 3,328,540,304.03	3,331,887,612.29	3,347,308.26
2044	$ 3,412,147,642.53	3,410,646,309.06	(1,501,333.47)
2045	$ 3,525,026,883.28	3,528,488,378.83	3,461,495.55
2046	$ 3,627,536,228.16	3,631,042,469.48	3,506,241.32
2047	$ 3,733,024,944.20	3,736,576,602.48	3,551,658.28
2048	$ 3,841,579,587.66	3,845,177,344.16	3,597,756.49
2049	$ 3,955,952,325.87	3,960,584,353.54	4,632,027.66

Table 9 Cascadia Versus Solar Tesla Cash Flows

Year	**Cascadia**	**Solar**	**Delta**
2019	$ (10,796,600.00)	$ (32,869,782.92)	$ (22,073,182.92)
2020	$ 1,721,019,007.22	$ 1,724,264,007.42	$ 3,245,000.20
2021	$ 1,771,096,731.04	$ 1,774,383,031.82	$ 3,286,300.78
2022	$ 1,822,630,466.07	$ 1,825,958,686.93	$ 3,328,220.86
2023	$ 1,875,662,520.11	$ 1,879,033,289.86	$ 3,370,769.74
2024	$ 1,920,440,847.48	$ 1,920,222,583.56	$ (218,263.92)
2025	$ 1,986,450,398.90	$ 1,989,927,992.21	$ 3,477,593.31
2026	$ 2,044,243,726.01	$ 2,047,765,811.77	$ 3,522,085.75
2027	$ 2,103,717,255.18	$ 2,107,284,500.77	$ 3,567,245.59
2028	$ 2,164,919,806.49	$ 2,168,532,889.31	$ 3,613,082.82
2029	$ 2,217,348,993.84	$ 2,217,095,668.10	$ (253,325.74)
2030	$ 2,292,771,916.63	$ 2,296,500,078.76	$ 3,728,162.13
2031	$ 2,359,468,843.10	$ 2,363,244,936.24	$ 3,776,093.14
2032	$ 2,428,104,671.00	$ 2,431,929,414.11	$ 3,824,743.10
2033	$ 2,498,735,734.96	$ 2,502,609,857.78	$ 3,874,122.82
2034	$ 2,560,051,832.55	$ 2,554,759,807.02	$ (5,292,025.54)
2035	$ 2,646,279,113.80	$ 2,650,298,562.86	$ 4,019,449.06
2036	$ 2,723,250,496.07	$ 2,727,321,580.43	$ 4,071,084.36
2037	$ 2,802,459,298.51	$ 2,806,582,792.71	$ 4,123,494.20
2038	$ 2,883,970,526.75	$ 2,888,147,216.92	$ 4,176,690.17
2039	$ 2,955,604,323.22	$ 2,955,293,888.42	$ (310,434.80)
2040	$ 3,054,236,543.47	$ 3,058,546,787.89	$ 4,310,244.42
2041	$ 3,143,064,240.26	$ 3,147,430,110.56	$ 4,365,870.30
2042	$ 3,234,473,823.44	$ 3,238,896,154.01	$ 4,422,330.57
2043	$ 3,328,540,304.03	$ 3,333,019,941.78	$ 4,479,637.75
2044	$ 3,412,147,642.53	$ 3,411,793,372.32	$ (354,270.21)
2045	$ 3,525,026,883.28	$ 3,529,650,396.88	$ 4,623,513.60
2046	$ 3,627,536,228.16	$ 3,632,219,666.63	$ 4,683,438.48
2047	$ 3,733,024,944.20	$ 3,737,769,206.43	$ 4,744,262.23
2048	$ 3,841,579,587.66	$ 3,846,385,586.00	$ 4,805,998.33
2049	$ 3,955,952,325.87	$ 3,961,808,467.84	$ 5,856,141.96

Limitations of Study

This study was based upon a model for technology that has been discussed, but not yet released to the public, so there is not enough information available to make a 100% accurate analysis. The methodology I used to estimate solar panel price is also flawed because Walmart would be able to achieve larger economies of scale resulting in a potentially lower price. This study also does not account for Tesla batteries potentially losing charging capability over time. This feature was not accounted for because there are no previous studies done on this for batteries of this size, and ideally, there would be minimal capacity loss in the five-year time frame for how long each truck will be owned before it is sold.

My model also goes off the assumption that diesel will continue to rise with the price of inflation. This is historically accurate, but retrospective analysis will not always prospectively predict what will happen. This study also does not recognize qualitative factors that could potentially negatively impact Walmart such as trucks having to return to the same distribution center after every shipment which would be a significant change in process.

Conclusion

For this project to work, Tesla would have to bring their trucks to market and produce at a high level to fulfill the backlog of orders that currently exist for this semi. If Tesla delivers on both the trucks and their proposed Megacharger, then this project is not only viable but also a strong strategic choice in general. The technology would be untested, so there could be potential flaws in the design, but after the trucks and chargers are substantially field tested, then Walmart could adopt this technology in order to save approximately $11,000,000 over time for a grid-based model or approximately $5,000,000 over time for a solar based model. Besides saving money based on my projections, Walmart will have more fixed costs instead of variable costs due to the mitigated reliance on the cost of diesel, so this would minimize risk associated with fossil fuel prices which would allow for Walmart to make more accurate profit predictions.

More significantly, the solar model would save a very large amount of CO2 emissions, whereas the grid-based model would still save a large amount of emissions dependent on how the grid-based energy is produced dependent on the energy mix within the locality. If Walmart implemented this project in the near future they would be taking a gamble by relying on Tesla while Tesla is experiencing significant financial difficulties, but they would also capitalize on the largest tax credit they could possibly receive and they would gain a very large image boost in the eyes of environmentally conscious customers. By implementing this plan, Walmart would achieve the goal of both being the lowest cost provider, while also differentiating themselves by having one of the cleanest means of delivery among major retailers.

Future Study

To properly analyze how much emissions could be saved, Walmart would need to complete a pilot for my model. There is currently an order placed for 30 trucks for a distribution center in Canada. Canada does not receive as many days of full sun as California, so they would not be the best candidate for a solar based model, however, they would be a good candidate to test the cost effectiveness of the grid-based model. Another good way to test out the effectiveness of my model is by introducing a differentiated cost of maintenance which I did not include because there is no historical for Tesla trucks. Moving forward the best way to complete this cost benefit analysis would be to have representatives from Tesla, Walmart, and a solar panel company so exact figures could be worked out.

The combination of cost efficiency and environmental impact is a very important future topic to research because as the effects of Global Warming become more visible, people will demand companies change policies, and the only way most companies will change current practices is if there is a compelling business case prompting them to do so.

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