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Staying One Step Ahead of the Growing Electric Vehicle Market

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Staying One Step Ahead of the Growing Electric Vehicle Market

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Honors Project

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Abstract

Electric vehicles are becoming more popular among drivers as they become more affordable and as people become more aware of the benefits of electric vehicles. Because of this, the demand for electric car chargers is quickly increasing across the country. This includes BGSU's campus. Right now, there are seven chargers available on campus, but with the trends in how the electric vehicle market is growing, BGSU should create a plan to install many more chargers to meet the increasing demand for charging stations. This strategy will allow BGSU to keep up with the growing electric vehicle market, which will additionally make BGSU more appealing to anyone using electric vehicles, such as students, staff, faculty, and people outside the BGSU community. It is important that BGSU responds to the growing market as soon as possible. This means costs to install more chargers will have to be analyzed, as well as where to place new chargers on campus and which types of chargers should be installed. BGSU must also work towards electrifying its university fleet—specifically, Campus Operations vehicles as they contribute the most vehicles to the university fleet. Therefore, I have analyzed purchasing and operating costs for relevant electric vehicles. The university would save money since gas is more expensive than electricity, and campus vehicles would be friendlier to the environment due to less greenhouse gas emissions. I also surveyed other university sustainability directors to see what other campuses are doing. It will take some time to install more chargers and electrify university vehicles, but a concrete plan to do so needs to be created, especially to satisfy BGSU's goal to be carbon neutral by 2040. Some of my biggest suggestions to BGSU include investing in at least one electric vehicle now, installing more electric vehicle chargers, and performing the required trenching for electric vehicle charger wiring whenever parking lots are being dug up.

Introduction

As we know, evolving into a more environmentally sustainable society is a growing concern in our world. With major global environmental concerns like climate change, increased carbon emissions, diminishing fuel sources, increased pollution, etc., the demand for using cleaner, renewable energy has never been greater. One of the biggest changes we can make to help combat those issues is to emphasize using electric vehicles. Electric vehicles do not require gasoline, so there is no exhaust emitted that could contribute to polluting the air or raise the global temperature, and as an added benefit, the electricity produced for electric vehicles can be generated from wind and/or solar, which have no emissions as well once manufactured. If millions of cars used daily were converted over to electric vehicles, it would make a huge impact on the amount of CO₂ emitted by vehicles every day. While the electric vehicle market is still new for many people and may not be affordable, it is growing at a very rapid pace and will be accessible to many more people over the next few years.

Due to how quickly the market will grow, it is crucial BGSU prepares for its growth. One way that BGSU can achieve this is by installing more electric vehicle chargers on campus. Not only will this keep BGSU ahead of the times, but it can also encourage people to invest in an electric vehicle over one requiring gasoline. This is especially important for future BGSU students, faculty, and staff who may need a way of charging their car while on campus. Having accessible charging stations could be a deciding factor for some people. It is also a good example to the community that BGSU values sustainability and is taking step to become an even more sustainable university.

Another form of action that BGSU can take to become more sustainable and stay ahead is to invest in electric vehicles for its university fleet. BGSU uses many vehicles around campus daily to perform a variety of duties. Parking enforcement trucks drive up and down parking lots all day, stopping all the time to issue citations or wait for people and cars to pass, all while burning fuel in the process, whereas an electric vehicle would not burn gas while idling. Various Campus Operations vehicles drive all over campus every day performing maintenance tasks. Shuttle busses drive around all day, moving people across campus or even off campus. There are many areas within BGSU's fleet that can be efficiently electrified. The challenge arises from choosing what should be electrified. Some vehicles are likely better off being gasoline-powered, such as Geology Department vans, since those vehicles need more range to perform their duties and are also driven quite infrequently, which could be a concern with electric vehicles. On the other hand, vehicles like parking enforcement trucks and campus operations vehicles could really benefit from being converted to electric. The costs of investing in electric vehicles and places to charge them will have to be weighed with the costs that come with gasoline-powered vehicles.

Through the survey that I created, I have been able to see what other campuses across the nation have done to respond to the growing electric vehicle market. I created this survey to ask questions about electric vehicle charging infrastructure and campus fleet electrification, and I sent it out to The Association for the Advancement of Sustainability in Higher Education (AASHE) mailing list, which includes campus sustainability representatives from across the country, along with Canada. BGSU's Sustainability Manager, Nick Hennessy, also forwarded the survey out to sustainability representatives across Ohio. Using the responses provided by survey takers, I will be able to better share with BGSU the planning and decision processes other campuses are using to react to the electric vehicle market. With this survey, BGSU may have a

clearer picture as to how to proceed with its current plan while also contributing new ideas that it could implement in the future.

The Survey

I wanted to collect information on what other campuses across the country are doing regarding electric vehicle chargers and electrifying vehicles on their campuses. Therefore, I chose to create and distribute a survey. When I decided I wanted to create a survey for sustainability representatives at colleges and universities across the country, I discovered I must undertake virtual training through the BGSU Institutional Review Board (IRB) since my survey would be classified as research involving human subjects. I, along with my primary project advisor Dr. Craig Zirbel, read through the training provided by the IRB for us to learn how to appropriately treat, respect, and protect the rights of the human subjects (survey takers) I would be contacting and requesting information from. After completing the training, I created a series of documents explaining my project to the IRB, received consent from the IRB, and showed how I would directly contact/recruit people to participate in my research.

Once I received IRB approval for my survey, I worked with my primary advisor and the BGSU Sustainability Manger, Nick Hennessy, to formulate the questions I should include in my survey. After finishing the survey, I sent it out through the AASHE mailing list, and Nick Hennessy forwarded it to sustainability representatives on Ohio campuses. The survey was available to be taken for a month, from October 25th, 2021 to November 22nd, 2021, after which I sent out a summary of the survey to the same mailing lists so anyone who took the survey could see the results of the survey (anyone who did not participate in the survey would also be able to see that summary). I also provided the opportunity for anyone who received the survey

recruitment email to be able to see all the live results to the survey, stored in a spreadsheet accessible via sharable link in the recruitment email. The summary I created for all the survey participants stated the following:

“Overall, eleven sustainability people from different colleges/universities responded to the survey. Responses came from seven different states and one Canadian province. The colleges/universities that responded were a combination of small-town, suburban, and urban, and they ranged anywhere from 1,800 students to 64,218. A majority of campuses charge students for either parking or both parking and electricity and utilize level 2 chargers, with a cost of charging that does not increase after parking for a set amount of time. Most demand for new chargers being installed comes from staff/faculty.

ChargePoint is the most popular charging network used and was praised for its friendly user interface and the good data it provides. Few decisions have been made as a result of the data provided by charging networks, but they may potentially help in the future. Most campuses received funding for new chargers from grants, but other sources included direct capital investment, gifts, parking fees, and local companies. Costs associated with installing chargers include equipment cost, installation cost, and network service cost. A single or dual charging station typically costs between \$10,000–\$20,000. Locations to install new chargers include by campus police, near freeways, by athletic facilities, and near employee lots. When deciding where to place chargers, the most common decision was to install chargers in lots where employees, students, and visitors can park. Other factors included proximity to electrical sources and any areas where a demand for more chargers can be met. There are few plans to install chargers in the near-future, although some ideas involved installing a couple new chargers a year, putting chargers near police

so those spots can be monitored, and putting chargers in lots where students, staff, faculty, and visitors can park. When it comes to electric vehicles on campuses, almost everyone is still in the brainstorming/discussion phase of figuring out how to electrify vehicles, which vehicles to electrify, and how to afford electric vehicles. A handful of campuses have already obtained electric vehicles, and other have electrified landscaping equipment as a start. The vehicles people wish to electrify the most are grounds vehicles, including vans and trucks, although there are very few electric truck equivalents in the market currently. Most people agree that chargers would be installed specifically for campus vehicles. Cost is the biggest factor when considering replacing gasoline vehicles with electric ones, specifically maintenance cost over the lifetime of vehicles, but greenhouse gas emissions, rebates, and range are also important elements.”

The results of this survey really helped me see a better picture of how other colleges and universities across the country compare to BGSU. With it, BGSU should be able to weigh the pros and cons of what other schools are doing along with what BGSU itself is doing and formulate and implement a plan that best benefits BGSU and satisfies its needs.

Installing More Electric Vehicle Chargers

Currently, BGSU has seven level 2 AC electric vehicle charging stations across campus. One in lot 20 by the Stroh Center, one in lot 8 by Falcon Heights, one in lot E next to the heating plant, and four in lot A next to the Maurer Center. With the rising demand of electric vehicles and therefore electric vehicle chargers, investment in more chargers will be required. The pressing questions that come with investing in more chargers are: Where should they be placed? What kinds of chargers should be placed where? How will they be funded?

There are a few places to prioritize when installing new chargers. One of these places is in lot 12—the large long-term parking lot surrounding the Field House. Students park their vehicles there for days at a time, many of which are only driven on weekends. Therefore, it may be a good investment to install some level 1 AC chargers in lot 12 to provide students who use electric vehicles a means to charge their car. They will not require a fast charge within a couple hours like commuters and staff/faculty may need, so the less expensive level 1 AC chargers would be appropriate, which provide around three miles of range per hour. This would be especially nice for students who wish to drive home during the weekend who live multiple hours away who need their car to be fully charged when they go to leave for the weekend. Of course, even for students who drive around town on the weekends or work a weekend job off campus, having a place to charge their car overnight would be a huge help to them.

Another great place to install chargers would be lot 5—the large commuter lot next to the cemetery, adjacent to a faculty/staff lot. Hundreds of commuting students use this lot on a daily basis, some of whom drive an hour or more from home to get to campus. Any student who commutes with an electric vehicle would benefit from available chargers in commuter lots, and as of today, only one charger is available to commuting students—the charger located in lot 8 next to Falcon Heights. Therefore, it would be very beneficial to commuting students if BGSU installed level 2 AC chargers in lot 5, but also in other commuting lots, such as lots 1 and 16 by the Moore Musical Arts Center, lot 10 by the ice arena, and lot 24 by the Stroh Center. Level 2 AC chargers would be great in these locations since people do not park there for very long but may still need a decent charge over an hour or two.

Installing some more level 2 AC chargers in faculty/staff lots would also be a good idea. Faculty/staff may remain on campus for about eight hours a day throughout the week, and some

likely live an hour or more away from campus. Therefore, much like the commuter students, they would benefit from the opportunity to be able to charge their vehicles. Lot N by the Wolfe Center would be a good location since that parking lot is very centrally located, relatively large, and has no chargers near it. Lots R and H by the Psychology Building may also be good candidates for chargers since neither has any chargers and are both decently sized parking lots.

Costs to install chargers can be expensive, depending on what kind of chargers are being installed and what has to be done first to make installing them possible, such as trenching and figuring out how to connect them to the electrical grid. The costs to consider when investing in a new charger include equipment cost, installation cost, and network service cost, such as ChargePoint, if network service is used. On average, the cost to install a new level 2 AC single or dual charger is anywhere between \$10,000 to \$20,000, based on the survey I sent out with the numbers that other people at colleges and universities reported. For BGSU specifically, the cost to install a ChargePoint charger is about \$10,000, as reported by Nick Hennessy.

To fund these chargers, BGSU has a few options. One possibility is grants. BGSU should take as much time as it can to look into whatever grants it may be able to apply for and receive that could fund electric vehicle chargers. Several schools responding to the survey I sent out received grants of their own, including BGSU in the past, which received the Clean Fuels Ohio grant. Donations can also be a great way to receive funding. BGSU surely has alumni who are interested in donating money to install chargers. Other potential donors may be out there, and it may be BGSU needs to somehow get the attention of those donors and appeal to them in order to build up incentive to donate to the university. Other schools responding to my survey stated they received donations from parents and local businesses as well. BGSU may also be able to receive funding from within the University, such as from the Green Fund or capital directly allocated

from the university to be used for electric vehicle charging infrastructure, which is a source that other schools from my survey stated they received funding from. There are luckily many different funding options for BGSU to explore.

Electrifying BGSU's Fleet

BGSU utilizes many different kinds of gasoline-powered vehicles, so I wanted to know which vehicles BGSU wants to replace with electric vehicles. Throughout the Fall 2021 semester, I met with the Sustainability Manager, Nick Hennessy, and Director of Campus Services, Eric Heilmeier, multiple times to discuss with them which vehicles I should focus on researching for the university. They informed me that BGSU utilizes mostly Ford pickup trucks and delivery vans, so I went to Ford's website and collected the numbers they provided for each vehicle of interest. With that, I was able to create an updatable Excel sheet (Appendix A) containing comparable data on hybrid and electric vehicles as potential replacements for gasoline-powered vehicles currently utilized around campus, and I presented it to the Transportation Subcommittee of the President's Council on Sustainability.

I compared two electric vehicles, one hybrid vehicle, and three gasoline-powered vehicles to show the major differences among each type. I analyzed three trucks and three delivery vans: A 2022 Ford F-150 (electric), a 2022 Ford Maverick Hybrid, a 2021 Ford Ranger (gasoline), a 2022 Ford E-Transit (electric), a 2022 Ford Transit Connect (gasoline), and a 2021 Ford Transit (gasoline). I did a side-by-side comparison on each vehicle's costs over a five-year and ten-year period. I factored in manufacturer's suggested retail price (MSRP), anticipated number of miles driven in a year, maintenance cost per mile, cost of gas per mile, cost of electricity per mile, and resale values after five and ten years. I then calculated the amount of

CO₂ emitted into the atmosphere by the gasoline vehicles and the estimated cost to directly remove that CO₂ from the atmosphere.

When looking at the individual costs, there are many important things to note. The most noticeable would be the much higher MSRP on electric vehicles. Over time, as supply of electric vehicles increases and they become cheaper to build, their MSRPs should decrease. Due to the higher MSRP though, the five-year and ten-year costs for electric vehicles are higher than those for the gasoline vehicles and the hybrid truck.

However, the cost of electricity vs gas per mile and the maintenance cost per mile are significantly lower for electric vehicles. Cost of maintenance per mile for the electric vehicles is 40% less—or \$0.042 less—than that for gasoline vehicles and 35% less—or \$0.033 less—than the hybrid truck. Looking at gas vs electricity, BGSU's cost of electricity per kilowatt hour is about \$0.10, according to the Director of Energy Management, Matt Rubel. With that number in mind, between the 2022 Ford Lightning and 2022 Ford E-Transit, the cost of electricity per mile is about \$0.05. On the other hand, BGSU's cost of gasoline averages around \$2.48 per gallon, according to the Director of Campus Services, Eric Heilmeier. With this number, the cost of gasoline per mile for the four vehicles I analyzed that utilize gasoline ranged between \$0.15 to \$0.28. This shows that the cost of gasoline per mile is three to six times more expensive than the cost of electricity per mile for the six vehicles that I researched. Over the course of the 6,000 miles that BGSU vehicles are estimated to drive each year, these differences in costs amount to hundreds of dollars every year.

Resale value is difficult to estimate this early, especially since some of these vehicles are not even used on the road yet. It is also hard to predict the demand for these vehicles five years and ten years into the future, partly because there are not many electric vehicles being resold that

are five or ten years old. However, much like gasoline vehicles, there will likely be a decent demand for electric vehicles as there will be many more of them in the market, which means they will be more accessible to buyers, both because of higher supply and lower prices. For my analysis, I used a 50% resale value after five years and a 25% resale value after ten years for rough estimates. These resale values really help recover the initial cost from the MSRP, so they benefit electric vehicles especially well.

After considering the MSRP, maintenance costs, gas/electricity costs, and resale value, we can look at the five-year and ten-year costs. For electric vehicles, the five-year and ten-year costs are higher than those for the hybrid and gasoline vehicles due to the higher MSRP, even though the total cost per mile is lower for electric vehicles. Therefore, if BGSU is trying to save the most money possible when purchasing new vehicles, investing in electric vehicles is not the best option. However, the biggest benefit from electric vehicles for the university comes from the ability to reduce CO₂ emissions into the atmosphere from gasoline and hybrid vehicles and to show people that BGSU is committed to promoting a more sustainable environment.

Recommendations to BGSU

There are several actions BGSU can take to respond to the growing electric vehicle market. These are:

1. Invest in more electric vehicle chargers around campus
2. Perform the required trenching for charger infrastructure and wiring when a parking lot is being dug up for other reasons
3. Focus more on finding grant opportunities by designating individuals or a committee to do so

4. Work with alumni to encourage gifts for electric vehicles and charging infrastructure
5. Invest in at least one electric vehicle now to allow BGSU to have experience in using an electric vehicle
6. Better enforce policies around campus that were established to promote a healthier environment

Earlier suggestions concerning chargers included installing level 1 AC chargers in long-term parking lots for students and installing more level 2 chargers in commuter lots and staff/faculty lots that do not already contain chargers and/or have no other chargers near those lots. In addition, a great way for BGSU to plan ahead in regard to installing more chargers is to perform the required trenching for charger infrastructure and wiring when a parking lot is already being dug up or renovated for a different purpose. BGSU could install the foundation to run electrical cables underground before chargers are ever installed. This way, when the day does come to install chargers, the process to connect chargers to the electric grid will be much simpler since part of the work was already done. This would save time and money since parking lots would not have to be dug up multiple times to install wiring for charging and for other projects the university decides to start.

Also as stated before, BGSU needs to focus as much time and energy as it can to seek out potential grant opportunities. There may be grants existing that the university could qualify for but does not know about yet. Perhaps the university could designate the task of researching and applying for grants to a committee or to individuals in order to increase BGSU's chances of finding grant opportunities that could help fund electric vehicle chargers and electric vehicles.

Another funding option I mentioned was donors. There are things BGSU can do to improve its chances of contacting interested donors. One of the best ways BGSU can be more proactive is to improve its publicity with the community by focusing on the actions BGSU has taken to be more sustainable. BGSU has done a variety of things to be a more sustainable university, such as planting many new trees around campus, devoting areas of the campus to be green spaces, installing solar panels overtop outdoor tables and benches to power outlets, beginning to convert lawnmowers to all-electric, and relying more on renewable sources of energy. However, the public may not realize what BGSU has done to be a more environmentally-friendly campus, and so BGSU does not get the attention from the community it may deserve. In fact, with the recent demolition of the Administration Building, many people in the community are upset because BGSU destroyed trees around the building in order to demolish it. What the community may not know is that BGSU planted many more trees than it regularly does to make up for the lost trees from the demolition. By being more open and vocal about what the university has done and continues to do to be more sustainable, people may have a more positive outlook towards the university, which may attract potential donors to help BGSU with its sustainability goals. The university is meant to act for the public good, and it could really benefit from informing people better about how its acting in favor of the public.

As for electric vehicles, it may not seem too realistic at first glance for BGSU to invest in many electric vehicles and replace gasoline-powered vehicles with them, especially since electric vehicles are more expensive for the time being and installing chargers will cost money. However, I think that BGSU should invest in at least one or two electric vehicles now. This way, BGSU can begin to experience for itself the advantages of using electric vehicles and learn how to handle any attending disadvantages. The earlier BGSU learns what it is like to use electric

vehicles, the better prepared it will be down the road when electric vehicle usage becomes a larger component in society. With the use of at least one or two electric vehicles, BGSU can show to the community that it is taking more steps towards becoming a more sustainable university. This can attract donors to BGSU who may want to help fund more electric vehicles, which would be amazing for the university. More electric vehicles being used by people coming to campus would help lead to a better demand for installing electric vehicle chargers, which is another action BGSU should emphasize to the public.

While the argument exists gasoline is not provided to students so electricity should not, electric vehicles are a growing element in the vehicle market that are much better for the environment and will become a greater influence. BGSU should be a leader in the community when it comes to promoting sustainable actions. Installing more chargers would be a good way for BGSU to encourage others to invest in electric vehicles. BGSU supporting this newer concept now would be an important action that BGSU should take, and it can all really begin with the investment into one or two electric vehicles. From there, BGSU can better gauge how electric vehicles fit into its fleet structure and what future vehicle investments to make.

Besides mainly investing in electric vehicles and electric vehicle chargers, there are other ways BGSU can be more sustainable by relying more on the individual user than the university as a whole. BGSU should work to reduce vehicle idling around campus, especially among Campus Operations vehicles. It has been noted some Campus Operations vehicles are left running for up to half an hour in the winter to allow them to warm up so drivers can get into a warm vehicle. While it is more comfortable for people using the vehicle, it is definitely not advantageous to the environment, the gas tank, or the increased car maintenance. Investing in electric vehicles would help solve this problem since there would be no tail-pipe emissions and

electric vehicles do not have to run such a large gasoline-powered engine just to heat up the cabin. BGSU should enforce a no-idling policy to reduce the negative environmental impacts from idling vehicles. This can be another action BGSU informs the community about toward creating a greener campus. Other seemingly small issues BGSU can continue to enforce and encourage are using less waste, recycling what can be recycled, and reusing as much as possible. While indirectly related to vehicles and chargers, these actions can bring even more attention to the university, which always increases the chances of attracting donors to directly help aid in increasing electric vehicle infrastructure around campus.

Conclusion

BGSU has a lot of steps before it can reach its goal of being carbon neutral by 2040. As outlined here, a great step towards achieving that goal is to focus on investing in more electric vehicles and electric vehicle chargers around campus. The electric vehicle market is rapidly growing and is expected to saturate the vehicle market by the end of the decade, if not sooner. It is crucial that BGSU stays ahead of this expanding market so it does not fall behind and become overwhelmed when more and more students, faculty, staff, and visitors start arriving to campus in electric vehicles, both new and old, and increase demand. If BGSU considers the recommendations I have provided, I am confident the university will be in a much better position to be a leader in sustainable actions that hopefully other people, businesses, organizations, and the community can also take. I am also confident these recommendations will be worth the university's time and money. More people need to prioritize protecting the environment if we want to continue enjoying all the amazing things this world offers us, and BGSU, being a public university, has a responsibility to prioritize this goal. The university should never stop

researching and investing in new ways to be more sustainable. This includes research in investment in electric vehicles. Even after initial purchases, the university should continue researching and investing in more efficient vehicles until ideally all vehicles are electric. Installing more chargers will promote public awareness to electric vehicle usage, provide more opportunities for people to charge their vehicles, and allow the university to charge its own vehicles. I hope what I discussed here can help BGSU formulate a concrete plan of action it can implement in the near future to benefit the public good, the future of the university, and the future of our planet.

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Appendix A

Table Breaking Down Costs of Fleet Electrification Vehicle Candidates

Vehicle		2022 Ford F-150 Lightning 	2022 Ford Maverick Hybrid 	2021 Ford Ranger 	2022 Ford E-Transit 	2022 Ford Transit Connect 	2021 Ford Transit 
Starting MSRP		\$39,974	\$19,995	\$25,070	\$45,000	\$25,175	\$35,270
Range (mi)		230	40mpg (city), 13.8gal tank	21/26 mpg, 18gal tank	126	24/28 mpg, 15.8gal tank	12/16 mpg, 25gal tank
Gross Battery Size (kWh)		125	N/A	N/A	76	N/A	N/A
Charge Time (Level 2 Charger)		10 hours	N/A	N/A	8 to 12 hours	N/A	N/A
Additional Notes		<ul style="list-style-type: none"> • Up to 2000lbs. payload capacity • 52.8 Cu. ft. of bed cargo space • 5' 7.1" long bed • 10,000lbs. maximum towing capacity • 14.1 Cu. ft. of front trunk cargo space • Up to 9.6kW of exportable power • Long range battery option available • Estimated cost per mile of \$0.061 according to Ford Authority 	<ul style="list-style-type: none"> • Up to 1,500lbs. payload capacity • 33.3 Cu. ft. of bed cargo space • 4' 6" long bed • 4,000lbs. maximum towing capacity 		<ul style="list-style-type: none"> • 3,800 – 4,290lbs. payload capacity • Up to 487.3 Cu. ft. of cargo space • Up to 6' 9" of height space inside • \$7,500 tax credit if purchased • Up to 2.4kW of exportable power 	<ul style="list-style-type: none"> • Up to 1,550lbs. payload capacity • Up to 123.2 Cu. ft. of cargo space • Up to 4' 1.8" of height space inside 	
		Click here for more info	Click here for more info	Click here for more info	Click here for more info	Click here for more info	Click here for more info
Starting MSRP		\$39,974	\$19,995	\$25,070	\$45,000	\$25,175	\$35,270
Annual Miles	6,000						
Maintenance Cost Per Mile		\$0.061	\$0.094	\$0.101	\$0.061	\$0.101	\$0.101
BGSU Cost of Fuel per Gallon (\$2.20 – \$2.75)	\$2.475						
Average MPG		0	40	23.5	0	26	14
Cost of Fuel Per Mile		\$0	\$0.062	\$0.105	\$0	\$0.095	\$0.177
BGSU Cost of Electricity per kWh (2021)	\$0.10						
Miles Per kWh (Assuming 90% Used Battery Size)		2.0444	0	0	1.8421	0	0
Cost of Electricity Per Mile		\$0.049	\$0	\$0	\$0.054	\$0	\$0
Running Cost Per Mile (Maintenance + Gas/Electricity)		\$0.110	\$0.156	\$0.206	\$0.115	\$0.196	\$0.278
5-Year Resale Value	50%	\$19,987	\$9,998	\$12,535	\$22,500	\$12,588	\$17,635
10-Year Resale Value	25%	\$9,994	\$4,999	\$6,268	\$11,250	\$6,294	\$8,818
5-Year Estimated Cost:		\$23,284	\$14,674	\$18,725	\$25,959	\$18,473	\$25,969
10-Year Estimated Cost		\$36,575	\$24,349	\$31,182	\$40,667	\$30,653	\$43,120
CO2 Tailpipe Emissions (grams/mile)		0	225	385	0	336	658
Annual CO2 Tailpipe emissions (tonnes)		0	1.35	2.31	0	2.02	3.95
Cost to Remove CO2 from Atmosphere (\$\$/tonne)	208						
Annual Cost to Remove CO2 from Atmosphere		\$0	\$281	\$481	\$0	\$419	\$821

[Link to Vehicle Spreadsheet](#)

Appendix B

List of survey questions

1. Your Name (Optional)
2. Your Position/Title (Optional)
3. Your Email (Optional)
4. Your College/University (Optional)
5. Your State
6. Is your college/university urban or suburban?
7. Approximate Number of Students at Your College/University
8. How many level 1 chargers are available on your campus?
9. How many level 2 chargers are available on your campus?
10. How many level 3 chargers are available on your campus?
11. For Level 1 chargers, does the user pay for parking, for electricity, or for both?
12. For Level 2 chargers, does the user pay for parking, for electricity, or for both?
13. For Level 3 chargers, does the user pay for parking, for electricity, or for both?
14. For Level 1 chargers, does the cost of using the parking space increase substantially after a set amount of time or charging?
15. For Level 2 chargers, does the cost of using the parking space increase substantially after a set amount of time or charging?
16. For Level 3 chargers, does the cost of using the parking space increase substantially after a set amount of time or charging?
17. If you answered "Yes" to any of the above three questions, please explain how the cost of using the parking space increases.
18. Where do you see most of the demand for new chargers coming from?
19. What charging network(s) do you use on campus?
20. Do you recommend the charging network(s) you use? Why or why not?
21. What decisions does the dashboard provided by your charging network(s) help make?
22. Where do you receive funding to install chargers?
23. If you received a grant/grants, what grant(s) did you apply for?
24. Describe a recent charger installation and tell the total cost and the factors that contributed to the cost.
25. Are there any specific areas on campus you plan to install chargers in?
26. How do you decide where to install new chargers?
27. What are your plans, if any, for installing chargers for residential and commuting students?
28. What are your plans, if any, for installing chargers for faculty/staff?
29. What are your plans, if any, for installing chargers for the community?
30. Are there other challenges you face when you consider installing more chargers besides costs, available space, and demand?
31. Any additional comments on car chargers around campus?

32. What discussions have there been about replacing gas/diesel university vehicles with electric ones?
33. What types of vehicles on campus can be electrified?
34. Where would electric university vehicles be charged, and would those chargers be available to other vehicles besides university ones?
35. What factors do you consider when determining the costs of replacing gas/diesel vehicles with electric ones?
36. Any additional comments on electrifying university vehicles?