2025

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Academic Paper — 5 Points

Score of 1	Score of 2	Score of 3	Score of 4	Score of 5
Report on Existing Knowledge	**Report on Existing Knowledge with Simplistic Use of a Research Method**	**Ineffectual Argument for a New Understanding**	**Well-Supported, Articulate Argument Conveying a New Understanding**	**Rich Analysis of a New Understanding Addressing a Gap in the Research Base**
• Presents an overly broad topic of inquiry.	• Presents a topic of inquiry with narrowing scope or focus, that is NOT carried through either in the method or in the overall line of reasoning.	• Carries the focus or scope of a topic of inquiry through the method AND overall line of reasoning, even though the focus or scope might still be narrowing.	• Focuses a topic of inquiry with clear and narrow parameters, which are addressed through the method and the conclusion.	• Focuses a topic of inquiry with clear and narrow parameters, which are addressed through the method and the conclusion.
• Situates a topic of inquiry within a single perspective derived from scholarly works OR through a variety of perspectives derived from mostly non-scholarly works.	• Situates a topic of inquiry within a single perspective derived from scholarly works OR through a variety of perspectives derived from mostly non-scholarly works.	• Situates a topic of inquiry within relevant scholarly works of varying perspectives, although connections to some works may be unclear	• Explicitly connects a topic of inquiry to relevant scholarly works of varying perspectives AND logically explains how the topic of inquiry addresses a gap.	• Explicitly connects a topic of inquiry to relevant scholarly works of varying perspectives AND logically explains how the topic of inquiry addresses a gap.
• Describes a search and report process.	• Describes a nonreplicable research method OR provides an oversimplified description of a method, with questionable alignment to the purpose of the inquiry.	• Describes a reasonably replicable research method, with questionable alignment to the purpose of the inquiry.	• Logically defends the alignment of a detailed, replicable research method to the purpose of the inquiry	• Logically defends the alignment of a detailed, replicable research method to the purpose of the inquiry.
• Summarizes or reports existing knowledge in the field of understanding pertaining to the topic of inquiry.	• Summarizes or reports existing knowledge in the field of understanding pertaining to the topic of inquiry.	• Conveys a new understanding or conclusion, with an underdeveloped line of reasoning OR insufficient evidence.	• Supports a new understanding or conclusion through a logically organized line of reasoning AND sufficient evidence. The limitations and/or implications, if present, of the new understanding or conclusion are oversimplified.	• Justifies a new understanding or conclusion through a logical progression of inquiry choices, sufficient evidence, explanation of the limitations of the conclusion, and an explanation of the implications to the community of practice.
• Generally communicates the student's ideas, although errors in grammar, discipline-specific style, and organization distract or confuse the reader.	• Generally communicates the student's ideas, although errors in grammar, discipline-specific style, and organization distract or confuse the reader.	• Competently communicates the student's ideas, although there may be some errors in grammar, discipline-specific style, and organization.	• Competently communicates the student's ideas, although there may be some errors in grammar, discipline-specific style, and organization.	• Enhances the communication of the student's ideas through organization, use of design elements, conventions of grammar, style, mechanics, and word precision, with few to no errors.
• Cites AND/OR attributes sources (in bibliography/ works cited and/or intext), with multiple errors and/or an inconsistent use of a discipline specific style.	• Cites AND/OR attributes sources (in bibliography/ works cited and/or intext), with multiple errors and/or an inconsistent use of a discipline specific style.	• Cites AND attributes sources, using a discipline-specific style (in both bibliography/works cited AND intext), with few errors or inconsistencies.	• Cites AND attributes sources, with a consistent use of an appropriate discipline-specific style (in both bibliography/works cited AND intext), with few to no errors.	• Cites AND attributes sources, with a consistent use of an appropriate discipline-specific style (in both bibliography/works cited AND intext), with few to no errors.

Impact of Electric Vehicles on Washington Air Quality

Word count: 4,331

Introduction

Electric vehicles (EVs) began gaining popularity with the introduction of the Toyota Prius in 1997, the first mass-produced hybrid EC. In 2006, Tesla Motors announced that they would be producing an all-electric luxury sports vehicle that spurred many other automakers to accelerate work their own EVs. Vehicular transportation is the leading cause of greenhouse gas emissions in the United States. Electric vehicles are marketed as a more environmentally friendly option to traditional gas-powered vehicles (GPVs). GPVs run on gasoline that emits greenhouse gases (GGs) during combustion. By eliminating gasoline from the system, EVs emit significantly less GGs than GPVs.

My research aims to answer the question "To what extent do electric vehicles lead to a reduction in greenhouse gas emissions and improved environmental health when comparing their emissions to gas-powered vehicles in Washington?" Many factors go into determining the total reduction of emissions by EVs, such as the fuel sources of GPVs and EVs, the number of EVs compared to GPVs in Washington, and the total amount of GGs and PM being emitted from each type of car. In this study, I will be focusing on emissions of carbon dioxide (CO_2), nitrous oxides (NO_x), and methane (CH_4) as the main GGs that cars emit. Additionally, this study will only focus on passenger vehicles and not commercial vehicles. These factors will determine how effective EVs really are in reducing these GGs. Importantly, the purpose of this study is to evaluate the influence that EVs have on environment and potential ways that GGs can be reduced. I believe that my research will find a correlation between EV adoption and GG reduction. However, I do not think that EVs make up a large enough percentage of the total vehicle population in Washington to have a significant effect on total emissions.

Literature Review

As the number of cars worldwide increases each year, it is important to understand their relation to GGs. In “Air Quality Changes in Cities during the COVID-19 Lockdown” researchers examine changes in air quality from countries and cities on a worldwide scale. They observed changes in CO_2, CH_4, and NO_2, as they were the most prevalent to change. They collected data by comparing levels of GGs during the lockdown to a sample period from before the lockdown. Their results show that restriction to urban mobility led to a reduction in particle matter and declines in CO_2, CH_4, and NO_2 (Adam, Tran, & Balasubramanian, 2021). This demonstrates both a relation between these pollutants and vehicles and a relation between amount of vehicle traffic and emission rates. Similarly, in an issue of *Atmospheric Environment*, Jes Fenger studies the link between the growing consumption of fossil fuels, urban air quality, and growing population rates. He evaluates energy consumption in areas that have a high urban population density to determine how increasing road traffic impacts GG emissions. Road traffic has a substantial negative impact across all continents, and vehicular traffic is the largest factor contributing to this issue in both developed and developing countries (Fenger, 1999). Both studies evaluate how the amount of road traffic in different circumstances impacts the total output of GGs and agree that increased vehicle usage causes GGs to increase as well. These studies provide reasoning for my research to center around the types of GGs that I chose to evaluate, as these air pollutants are most directly linked to road traffic. Additionally, these conclusions will guide my research as they demonstrate that vehicle usage increases GG emissions, so that I am able to evaluate the extent that EVs reduce these emissions with the understanding of this correlation. While both studies examined the change in emissions due to increased or decreased road traffic all together, my research differs as I will consider how emission rates change when there is a shift towards EVs and away from GPVs.

The impact of EVs in Washington is also dependent on the number of EVs that are driven in comparison to GPVs. The research paper, *Impact of EVs on Global Warming,* attempts to create a connection between the transition to EVs and a reduction of CO_2 worldwide. The researchers collected data by examining CO_2 trends over the past 30 years and comparing these trends to electric usage for transport and the number of Tesla's sold globally since their release. The results showed that the current level of adaptation of EVs is not significant enough to make a significant difference in total CO_2 emissions worldwide. However, they did find that both electric usage for transportation and the number of electric cars globally have increased (Sethu, Sheng, & Marican, 2022). The article *Analysis of the Electric Vehicle Adoption Over the United States* provides context about the factors that lead to the adoption of EVs. The researchers examine the socioeconomic factors related to electric car adoption using a modal split model to determine the travel demand across all popular modes of transportation. Their results demonstrate that as income per capita increases by region, so do the number of EVs. They also found that increasing gas prices and decreasing electricity prices lead to a higher rate of EV adoption (Soltani-Sobh, Heaslip, Stevanovic, Bosworth, & Radivojevic, 2017). This study explains why the adaptation of EVs globally has not made a significant difference, as EVs are related to higher incomes and will not be as common in lower income areas. These studies present a gap in research surrounding EV adoption and decreased GG emission that I will answer with my focus on Washington state. Instead of having a global perspective like the study *Impact of EVs on Global Warming*, I will be looking at an area that has a higher income per capita than the world's average. Furthermore, the gas prices in Washington are some of the highest in the United States. These factors may provide incentive for Washington residents to purchase EVs at a higher rate than they are being purchased globally. My research will examine the number of electric cars in Washington in relation to GG emission to determine if a larger ratio of EVs to GPVs lowers the total emissions statewide.

The benefits of reduced GG emissions are partly dependent on the region being examined. A study done by Kenneth Small and Camilla Kazimi analyzes the monetary impact of CO_2 emissions and global warming on the Los Angeles region. They traced links between emissions from motor vehicles and adverse consequences, then placing economic values on those consequences. It was found that air pollution and health impacts cost approximately 3 cents per mile for every car driven in the region (Small & Kazimi, 1995). This study was done in 1995, before widespread use of EVs, so it does not account the ability of EVs to alleviate the need for gasoline. The article *Autonomous Electric Vehicles Can Reduce Carbon Emissions and Air Pollution in Cities* highlights how the EV can reduce GG emissions. Using a dynamic model to assess the environmental impacts of electrified transportation, it was discovered that adoption of EVs can reduce GGs by up to 34% by 2025 (Ecran et al., 2022). This would be a substantial reduction of GG and would have noticeable benefits for the environment. I did not find any study that examined both the impact of reduced GGs from electric vehicle usage and the benefit this would bring to the Washington environment. Washington has a unique landscape, encompassing forests, oceans, and lakes, all which have indigenous plants and animals that are affected by global warming. Additionally, humans are impacted by air quality and environmental changes. My research will determine the amount EVs reduce GGs so that I will be able to draw conclusions on the implications EV adoption has for Washington residents and the environment.

Method

Overview

The method used in this study is a quantitative correlation method. There are four main steps: 1) record the number of EVs and GPVs in Washington between 2016 through 2024, 2) calculate the amount of CO_2, NO_x, and CH_4 that the GPVs produce and the EVs produce in Washington, 3) record the amount of CO_2, NO_x, and CH_4 that was produced each year from 2016 through 2024, and 4) determine the amount that EVs reduce GG emissions from GPVs. In order to gather this data, I used government reports from the Washington State Department of Ecology, United States Environmental Protection Agency, and the Washington State Open Data Portal.

EV and GPV Numbers

The first step of my study involved recording the number of EVs and GPVs over a ten-year period to determine how EV adoption is increasing statewide. I collected data from the Washington State Open Data portal on December 31st of each year from 2016 to 2024. I intended to use a ten year data range of 2014 through 2024, however there was not significant data for EV ownership in Washington state before 2016. By collecting data on the last day of the year, I made the 2024 data the most current so that this study would provide a relatively updated analysis of EVs impact. Using this data, I calculated the percent of EVs in Washington each year by finding the ratio of EVs to the total number of cars in order to highlight a trend in EV adoption.

$$\textit{percent of EVs in Washington} = \textit{number of EVs} \div \textit{all vehicles}$$

This data will highlight the adoption trends of EVs in order to determine if a growing percent of EVs will have effects on statewide emissions.

GG Emissions from EVs and GPVs

After establishing the number of EVs and GPVs in Washington, I used statistics from the United States Environmental Protection Agency (USEPA) to calculate the amount of CO_2, NO_x, and CH_4 that the GPVs and EVs in Washington produce each year. CO_2, NO_x, and CH_4 were determined to be the main GGs emitted from vehicles, so this study focuses on these GGs as the total emissions from vehicles. Despite variation among different vehicle models in GG emissions, I used the reported USEPA average for passenger vehicles, as this study focuses on passenger vehicles. On average, one GPV produces 4.6 metric tons (4,600 kilograms) of CO_2 per year, 11 kilograms of NO_x per year, and 7 kilograms of CH_4 per year (United States Protection Agency, 2024). Using these averages, I determined the amount of CO_2, NO_x, and CH_4 produced by GPVs each year by multiplying the average by the number of GPVs in Washington.

$$GPV\ total\ emissions = GPV\ average \times number\ of\ GPVs$$

This data accounts for the GGs that GPVs produce, which I will compare to the total amount across all GG producers to highlight the impact that transportation has on total GG emissions. While EVs do not run on gas, they still emit some GGs because approximately 20% of electricity in Washington state comes from coal and natural gas, which are not clean energy sources. On average, one EV uses 7,200 watts of electricity to charge, travels 250 miles on one charge, and an average Washington resident drives 9,819 miles each year (United States Protection Agency, 2024).

$$EV\ total\ electricity = 7{,}200\ watts \times (9{,}819\ miles/250\ miles)$$

This equation approximates the amount of electricity one EV uses each year in Washington. One kilowatt of coal and natural gas electricity produces on average 1.02 kilograms of CO_2, 1.5

grams (0.0015 kilograms) of NO_x, and 1 gram (0.001 kilograms) of CH_4. Using this information and considering that only 20% of electricity in Washington produces GGs, I determined the amount of CO_2, NO_x, and CH_4 that EVs in Washington produce each year using the equation:

$$\textit{EV total emissions} = \textit{number of EVs} \times (\textit{electricity average} \times 0.2)$$

This data accounts for the amount of GGs that EVs produce in Washington. To accurately compare the emission rate from EVs to GPVs, I calculated the ratio of GG from EVs to the number of EVs and compared this to the ratio of GG from GPVs to the number of GPVs for each type of GG in this study and for each year.

$$\textit{EV emissions} \div \textit{number of EVs} : \textit{GPV emissions} \div \textit{number of GPVs}$$

This ratio effectively compares the impact of EVs to the impact of GPVs, which I used to come to conclusions about the overall impact of EVs on emissions in Washington state.

Total Emissions in Washington

After I determined the GG emissions from vehicles, I recorded data on the total statewide emissions to identify the impact of vehicles on total emissions. I used yearly GG reports from the Washington State Department of Ecology to collect data for CO_2, NO_x, and CH_4 and total emissions over the 2016 through 2024 period. This data will be used to compare the vehicle emissions to total statewide emissions to draw conclusions about the impact of cars on Washington as well as the impact of electric vehicles on Washington.

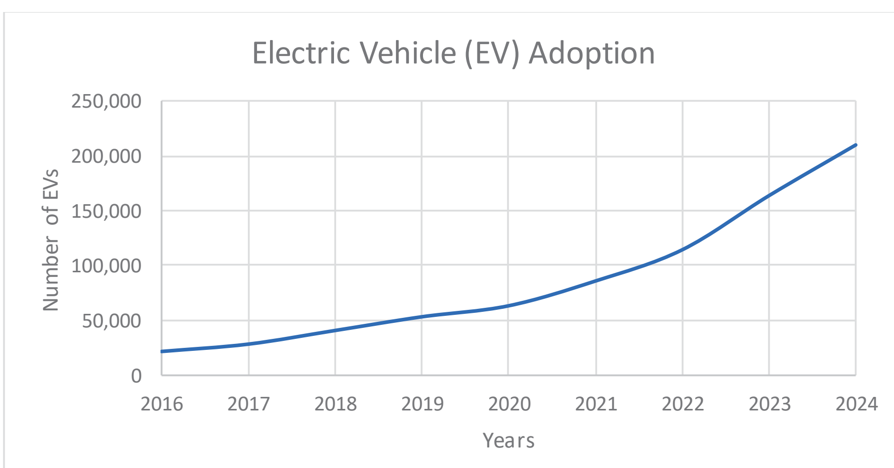
Data Comparison

After collecting all the data for the previous three steps in an excel spreadsheet, I began analyzing it holistically to draw conclusions about the impact of EVs on the environment and people. I created graphs to model the changes in EV and GPV ownership and compare GG emissions from both vehicles over the eight-year period. Then I compared emissions from EVs to GPVs. In order to effectively determine EVs benefit, I evaluated the total emissions from vehicles if they were all gas-powered and compared this to the total emissions from vehicles if they were all electric. Next, I related this figure to the amount that experts believe GGs must be reduced by to reverse climate change, which researchers from Stanford estimate to be about 50%. Using this overall analysis, I gathered my results of the study to determine the effectiveness of EV on the environment and human health.

Results

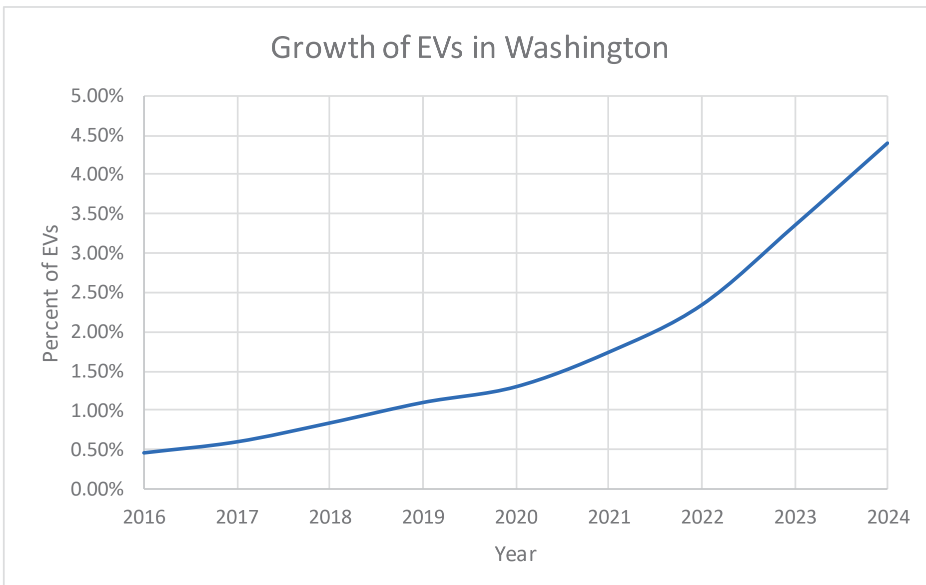
All data was collected over an eight-year period in all counties of Washington state. For the first part of my research, I began collecting data regarding the growth of EVs in Washington between 2016 and 2024. Using data from the Washington Department of Licensing, I collected information regarding the EV and GPV population in all counties in the state during my time and used this data to analyze trends in EV adoption.

Graph 1



Graph 1 shows the number of EVs owned by Washington residents between 2016 and 2024. Initially, there were 21,762 EVs owned in 2016, which increased by 863.4% to 209,819 at the end of 2024. This represents an EV adoption rate of approximately 31% greater than the previous year each year, demonstrating an exponential relation.

Graph 2



Graph 2 is another analysis of EV adoption statewide. However, it analyzes the percent of EVs within the total vehicle population to determine if Washington residents are becoming more likely to purchase EVs or if the market for cars is growing as a whole and EVs and GPVs are both increasing in population simultaneously. This data reveals that EVs are becoming a larger percentage of the total vehicle population, meaning residents are more likely to own an EV in 2024 than they were in 2016.

To understand the impact that the number of EVs and GPVs have on GG emissions in Washington, I used the data I found in the first part of my results to determine the amount of

GGs produced each year for both types of vehicle. Additionally, I used an EV constant value and a GPV constant value for CO_2, NO_x, and CH_4 that represented the average amount of emissions one vehicle produced each year on average.

Table 1

# of EVs	Year	EV CO_2 Emissions (MT)	EV NO_x Emissions (MT)	EV CH_4 Emissions (MT)
21,762	2016	6276.1608	9.227088	6.158646
28,417	2017	8195.4628	12.048808	8.042011
40,853	2018	11782.0052	17.321672	11.561399
53,318	2019	15376.9112	22.606832	15.088994
63,337	2020	18266.3908	26.854888	17.924371
85,891	2021	24770.9644	36.417784	24.307153
114,301	2022	32964.4084	48.463624	32.347183
163,621	2023	47188.2964	69.375304	46.304743
209,819	2024	60511.7996	88.963256	59.378777

Table 1 shows the amount CO_2, NO_x, and CH_4 produced by EVs each year from 2016 through 2024 in metric tons. The amount of GG emissions continues to grow parallel to the number of EVs.

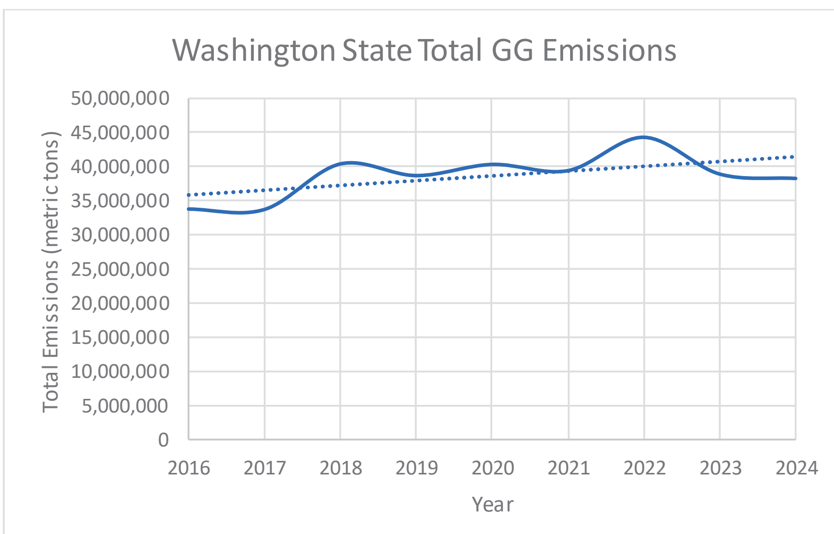
Table 2

# of GPVs	Year	GPV CO_2 Emissions (MT)	GPV NO_x Emissions (MT)	GPV CH_4 Emissions (MT)
4,679,422	2016	21525341.2	51473.642	32755.954
4,711,098	2017	21671050.8	51822.078	32977.686
4,797,364	2018	22067874.4	52771.004	33581.548
4,870,604	2019	22404778.4	53576.644	34094.228
4,847,538	2020	22298674.8	53322.918	33932.766
4,847,873	2021	22300215.8	53326.603	33935.111
4,765,682	2022	21922137.2	52422.502	33359.774
4,724,041	2023	21730588.6	51964.451	33068.287
4,568,337	2024	21014350.2	50251.707	31978.359

Table 2 displays the amount of CO_2, NO_x, and CH_4 produced by GPVs each year from 2016 through 2024 in metric tons. The amount of GGs emitted from GPVs is substantially more than the GGs emitted from EVs. However, GPVs represent the majority of the vehicle population in Washington state.

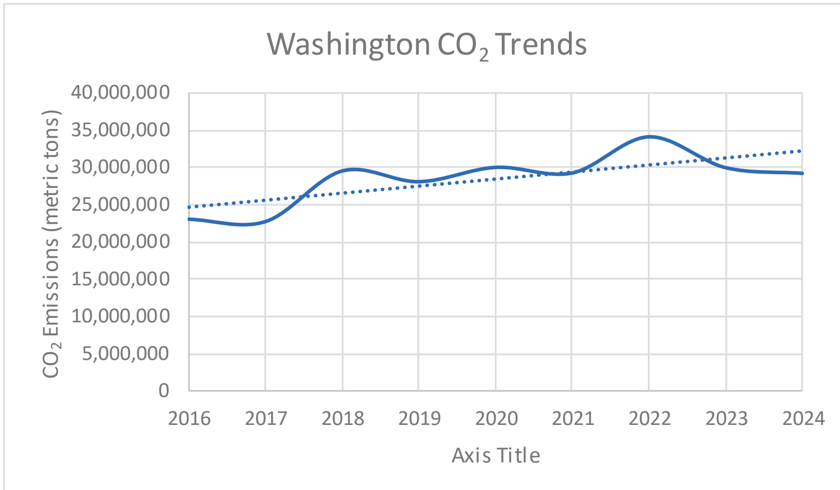
The third section of my results examines the total trends of GG emissions statewide across all GG producing sectors. Using data from the Washington Department of Ecology, I discovered the trends in total GG emissions, CO_2 emissions, NO_x emissions, and CH_4 emissions. These trends will be used to determine the overall impact that EVs have on reducing total GG emissions statewide.

Graph 3



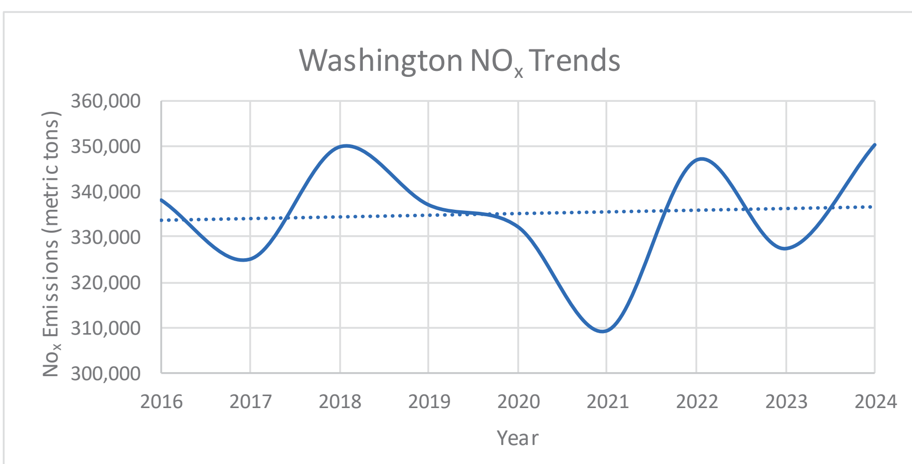
Between 2016 and 2024, GGs have had an upward trend, despite fluctuations each year. The trendline in Graph 3 shows an average increase of approximately 700,000 metric tons of GGs each year.

Graph 4



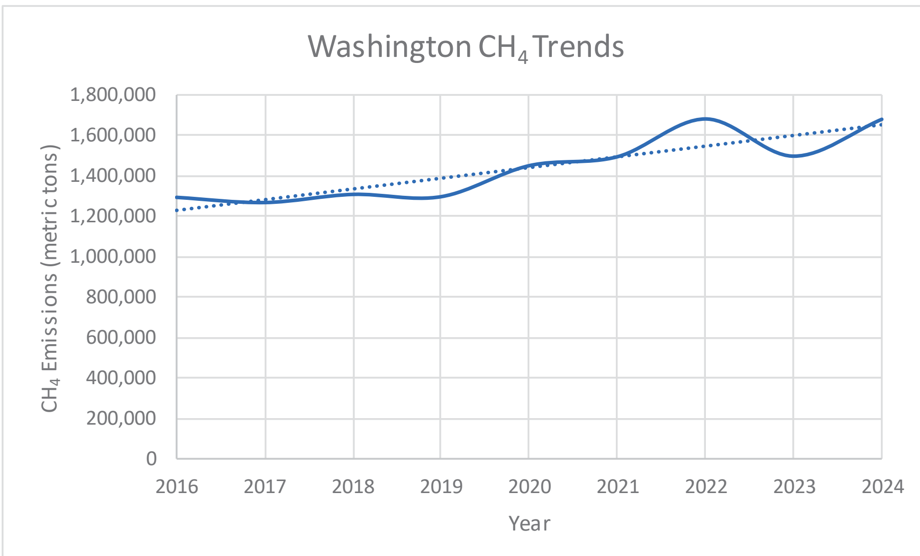
Like total GG emissions, CO_2 emissions have an upward trend pattern, with fluctuations by the year. Graph 4 demonstrates that CO_2 emissions appear to be increasing more rapidly than overall GG emissions, as CO_2 emissions increase by approximately 875,000 metric tons each year on average.

Graph 5



Unlike total GG and CO_2 emissions, NO_x emissions have a near zero growth over the eight-year period. NOx emissions stay within a 40,000 metric ton range and increase by approximately 6,000 metric tons in total between 2016 and 2024, less than 1,000 metric tons a year on average. Graph 5 shows a near horizontal trendline, indicating little increase in NO_x.

<u>Graph 6</u>



CH_4 emissions have an upward trend over the past eight years, increasing more than NO_x but not as much as total and CO_2 emissions. Unlike other trends among the graphs, Graph 6 shows that CH4 has relatively low fluctuation by year in its emission level, and its yearly emissions follow the trendline closely. The trend demonstrates that CH4 has grown 50,000 metric tons in emissions each year during the period.

Lastly, the previous three sections of data were combined to analyze the overall impact of EVs on GG reduction. Combining both the number of EVs and the number of GPVs into a total statewide vehicle population, I considered total emissions if all the vehicles were to be electric and if all the vehicles were to be gas powered. In 2024, if all vehicles in Washington were electric, they would produce 1,378,020 metric tons of CO_2, 2,206 metric tons of NO_x, and 1,352 metric tons of CH_4. In comparison, if all vehicles in Washington were gas-powered, they would produce 21,979,518 metric tons of CO_2, 52,560 metric tons of NO_x, and 33,447 metric tons of CH_4. This means that if all of Washington's vehicles were electric, they would emit 6% of the CO_2, 4% of the NO_x, and 4% of the CH_4 that an entirely gas-powered vehicle population would emit.

Discussion

The first significant finding of this study is that EVs are increasing in popularity and experiencing higher adoption rates over the past eight years. The data found regarding EV adoption shows an interest in cleaner energy sources, as the trend is a quadratic relation. Not only are EVs increasing in ownership, the rate at which they are increasing is also increasing. This demonstrates increased popularity of EV and potential for higher percentages of EVs in the coming decade. The motives for EV adoption are not only reducing GGs, but also The motives for EV adoption are not only reducing GGs. Considering that Washington state has some of the highest gas prices in the United States, many residents that choose to purchase an EV over a GPV factor the financial benefit that a gasless vehicle would give them. Additionally, some EVs, such as Tesla, are seen as luxury vehicles, providing a social status motivation.

Focusing on EV and GPV emissions, this study effectively estimated the total CO_2, NO_x, and CH_4 emissions from each type of vehicle across all Washington counties during the period of 2016 through 2024. The data shows that GPVs make up a much larger portion of GGs, but this is partially due to their more widespread popularity. Additionally, the data showed that CO_2 had the greatest emissions by far, and the greatest positive rate of change of emissions. This indicates that CO_2 is the most significant GG that vehicles emit. However, several thousand metric tons of NO_x and CH_4 are emitted each year from EVs and GPVs, demonstrating the importance in including them in this study. Furthermore, NO_x and CH_4 are considered to be more potent GGs because they are able to trap more heat in the atmosphere than CO_2. The data in the tables shows that vehicles have a large impact on environment, regardless of fuel source.

Nonetheless, the results indicate that EVs are substantially less harmful in terms of GG emissions than GPVs. By calculating the total emissions if all the vehicles in Washington were electric and comparing this to the total emissions if all the vehicles in Washington were gas-powered, it is clear that EVs produce much less CO_2, NO_x, and CH_4. Using data regarding the total emissions across all GG emitting sectors, I observed that vehicles make up more than half the total statewide GG emissions. The Stanford Woods Institute for the Environment projects that GG emissions must be cut by 50% to reverse climate change. If all vehicles were electric, this would cut vehicular GG emissions to less than 6% of their original emissions and cut the total GG emissions in Washington by nearly half. This supports my hypothesis that adopting EVs at a higher rate will lead to a decrease in GG emissions in Washington state and have beneficial impacts on the environment, yet they have not been adopted at high enough rates to have substantial impact. The findings show a connection between EV adoption and a significant reduction in GGs, highlighting that EV adoption plays a role in the effort to slow down global warming.

Furthermore, reducing GGs through EV adoption will benefit human health in Washington state. NO_x and CH_4 are both ground-level ozone, which is an air pollutant that hovers near the ground. Also known as smog, ground-level ozone can have serious negative impacts on respiratory health, particularly for people suffering with asthma. Ground-level ozone can also cause crop and agriculture complications, blocking out sunlight and damaging plants. This can reduce crop yields and shorten food supplies for Washington residents.

Finally, ocean acidification is primarily caused by the absorption of CO_2 from the atmosphere into the ocean. Increasing the acidity of the ocean has a negative impact on marine animals, particularly shellfish in the Washington state and Pacific coast area. Lower pH levels make it difficult for shellfish to form their structures and shells, exposing them to the open water and allowing them to die very quickly. Many people in Washington and along the Pacific coast eat shellfish, which to many is an important part of their diet. Furthermore, decreasing shellfish populations will impact the food chain as animals that prey on shellfish will have to find other food sources. Reducing CO_2 will help to preserve native Washington shellfish species while also maintaining a food supply for Washington residents.

Conclusion

Overall, this study suggests that EV adoption leads to a reduction of GGs in Washington state, with the decline of GPVs alongside this adoption. The three most environmentally threatening GGs (CO_2, NO_x, and CH_4) all have significantly lower emissions rates coming from EVs than GPVs. By choosing to look at these three gases, I simplified the process of calculating GG emissions while maintaining accurate data, as these GGs make up the vast majority of GGs emitted from vehicles. Despite the reduction in GGs that EVs provide in the transportation sector, overall GG emissions continue to slowly increase in Washington. A limitation of this study is that, even as the largest GG producing sector, transportation does not account for all GGs. Because of this limitation, it is challenging to accurately evaluate the impact that EVs have on total statewide emissions; however, it is evident that EVs significantly reduce GG emissions when being compared to GPVs. This illustrates that despite other GG producing sectors increasing their GG outputs, the output from vehicles is declining. This is evident in the ratio of EV emissions to GPV emissions when considering the increase of EV owners and the beginning of decline of GPV ownership.

The findings in the study highlight a correlation between EV adoption and environmental health. Previous researchers have determined a relationship between rising GGs and global warming, human health concerns, and wildlife destruction. This study connects the GGs emitted from cars to environmental challenges and explains the relationship between EV adoption and reduced environmental damage.

Future Directions

This study helps to fill a gap of climate change research with a focus on the impact of vehicles on this issue. Specifically, this study effectively determines how the adoption of EVs is effective at reducing GG emissions using data from Washington state. By focusing on Washington state as the scope of my research, I was able to determine the extent that EV adoption rates impact GG emissions in a region where a significant portion of the population can afford EVs. Additionally, this region allowed me to collect enough accurate data in the time frame I was given to draw meaningful conclusions. As EVs are still a new and emerging technology, it is important to continue to research their impact on GG emissions by repeating this study for future decades and in other U.S. states as well as other countries.

Considering that this study only accounted for GGs emitted during an EVs use, further study into the total emissions produced by EVs from processes before ownership, such as resource sourcing, manufacturing, and shipping, would provide a more holistic perspective of the emissions produced by EVs. This may require a series of experiments and would expand beyond the scope of Washington state, as materials used in EVs come from other countries. Additionally, some EVs are manufactured outside of the U.S., which would differ the manufacturing processes and increase the work done to ship the EVs to the U.S., and further to Washington. This study also raised questions regarding the trends of EV adoption, particularly whether this rate will grow exponentially or begin to slow in rate of adoption.

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Academic Paper

Note: Student samples are quoted verbatim and may contain spelling and grammatical errors.

Overview

NEW for 2025: The question overviews can be found in the *Chief Reader Report on Student Responses* on AP Central.

Sample: F
Score: 3

This paper earns a score of 3. A research question can be found on p. 1: "To what extent do electric vehicles lead to a reduction in greenhouse gas emissions and improved environmental health when comparing their emissions to gas-powered vehicles in Washington?" This question slightly shifts focus on p. 4: "My research will examine the number of electric cars in Washington in relation to GG emission to determine if a larger ratio of EVs to GPVs lowers the total emissions statewide."

There is an attempt to narrow the scope of the topic to certain greenhouse gases and to commercial vehicles (pp. 1-2). The method then is identified as a quantitative correlation with four main steps, outlined on p. 5. Because the secondary data collected is further treated with calculations with formulas (pp. 6-7) and using a constant EV value to extrapolate information (p. 9-10) this goes beyond a report of existing knowledge. The research question does not suggest comparing an all electrical vehicle versus an all gas vehicle scenario which then makes the analysis step on p. 8 questionably aligned: "In order to effectively determine EVs benefit, I evaluated the total emissions from vehicles if they were all gas-powered and compared this to the total emissions from vehicles if they were all electric." The paper does circle back to this in the last paragraph of p. 13 into p. 14, but there is no explicit explanation for why this is necessary to address the research questions as they were written. The four steps the paper outlines are reasonably replicable, but they are not defended and connected to the literature review. The new understanding on p. 16 conflates correlation with causation "this study suggests that EV adoption leads to a reduction of GGs in Washington state" without considering other confounding variables that could result in fluctuations of GGs.

This paper does not earn a score of 2. The method is reasonably replicable, and there is a narrowing topic that is carried throughout. The literature review does present varying perspectives from scholarly sources. The communication is competent and not general and has few grammatical and citation errors.

This paper does not earn a score of 4. The geographic gap asserted on p. 4 of Washington is not defended through the literature review that this location requires further study. There is some logical defense of individual steps, but there is no defense of the quantitative correlation which was the analysis used to draw the new understanding. There are some implications that connect back to the literature review (p. 4) regarding the implications of ocean acidification on shellfish (p. 16), but this is overgeneralized as there was only one line about implications to oceans and lakes in the literature review.