|  |
| --- |
| Masters of Public Policy Administration |
| FLOORING THE GAS |
| Reducing State Vehicle Emissions Through Policy Action |

|  |
| --- |
| Chris Skidmore  4-26-2021 |

Table of Contents

[Executive Summary 2](#_Toc71097789)

[Introduction 5](#_Toc71097790)

[Legal Background: Who Has The Power to Act 7](#_Toc71097791)

[The Clean Air Act 7](#_Toc71097792)

[Massachusetts v. EPA 8](#_Toc71097793)

[First Lever: Taxation 11](#_Toc71097794)

[Registration Tax 13](#_Toc71097795)

[Second Lever: Cap-and-trade 14](#_Toc71097796)

[Third Lever: Supporting Electric Vehicles 16](#_Toc71097797)

[Fourth Lever: Enhanced Fuel Economy Standards 18](#_Toc71097798)

[Feasibility 19](#_Toc71097799)

[Increasing Taxes 20](#_Toc71097800)

[Proposition 13 20](#_Toc71097801)

[Washington’s Failed Carbon Tax Initiatives 21](#_Toc71097802)

[Impact of Taxation 23](#_Toc71097803)

[Supporting Electric Vehicles 24](#_Toc71097804)

[Enhancing Fuel Economy Standards 26](#_Toc71097805)

[Alternatives Analysis 27](#_Toc71097806)

[Conclusion 30](#_Toc71097807)

[References 33](#_Toc71097808)

# Executive Summary

Increased housing costs in the state of California have pushed more and more residents to the suburbs and exurbs. As a result, driving distances, commutes, and overall vehicle miles travelled (VMT) have been gradually increasing over the last decade. With the known relationship between tailpipe emissions caused by increased driving and climate change, the increasing VMT trend is concerning for California’s ability to meet its climate goals. California has multiple policy levers to pull to reduce emissions from single-passenger vehicles. This report provides a background of the potential policy levers to pull and an analysis of the feasibility of each.

Passed in the 1970s to reduce smog and pollution causing direct harm to the public, the Clean Air Act has given California the power to regulate emissions more strictly than the federal government. Through the years, the Act has become more defined in who has the power to act and who must. After initially refusing to act, the Supreme Court case of Massachusetts v. EPA helped bring carbon emissions into the list of pollutants the EPA is required to protect against. The case of Chrysler-Jeep v. Goldstene solidified California’s ability to apply for a waiver with the EPA to regulate emissions more strictly than the federal government.

To discourage consumption of carbon-emitting gas, California has the option of increasing taxes on goods such as gasoline. California has introduced a gas tax to help fund transportation projects, but could go further in the way other governments have such as in the United Kingdom where a carbon tax has helped the country’s emissions fall to levels not seen since the late 19th Century.

California has been able to squeeze out emissions usage by capping the total emissions state-wide through the cap-and-trade program. Introduced in 2012, the cap-and trade program has helped create a more market-friendly approach than standard taxation by creating a carbon market. The state can reduce the total amount of emissions annually to meet emissions goals set by legislation such as AB 32 while also generating revenue.

While implementing tools to restrict consumption of carbon-goods, the state is also investing heavily in increasing the market for electric vehicles. Electric vehicles provide a significant emissions improvement over conventional internal combustion vehicles. California has set the goal of 5 million zero-emission vehicles (ZEV) by 2030, or 30 percent of all vehicles.

Through the power from the Clean Air Act, California can enact especially strict fuel economy standards. Referred to as Pavey limits, this allows the state to reduce emissions from vehicles annually by 4.9 percent.

In a review of feasibility of taxation, electric vehicles, and fuel economy standards, each brings their own benefits, but also face nuanced challenges from barriers of passage or optimization of efficiency. Taxes are especially politically difficult in California due to Proposition 13, which requires a two-thirds majority in each house to enact new taxation. Electric vehicles, especially plug-in types, are only realizing carbon reduction benefits if the grid it sources energy from is also a low carbon emitter. Fuel standards are effective in reducing emissions from vehicles in the state but allow an inefficiency on the national net-level where the fuel standard is not as strict as in California.

Many of the levers discussed encourage a change of behavior, but the issue of climate change is largely driven on the systematic level and not through individual choices. Proposition 13 has changed the way we build our cities by limiting property tax revenue from residential property and thus incentivizing cities to approve more commercial zoning and less residential zoning. This increases sprawl, commutes, and thus, emissions.

California policymakers will need to combat climate change with every tool available to its disposal. Understanding the nuance of traditional policy tools discussed can help reduce the inefficiencies, potential pitfalls, and externalities. While these tools are effective, reducing vehicle emissions is also a systematic issue. California could help address the local systematic challenges through a modification of Proposition 13 to build more sustainable communities.

# Introduction

Every weekday, Bruce Simmons rises before the sun. In the farming community of Los Banos, California, waking up early is not uncommon. Instead of being met by livestock or fields, Mr. Simmons is met with the chirps of a car unlocking, followed by a ninety-minute commute to his job as a technology research job in Silicon Valley. He is a part of 20% of the rural community population in California commuting long distances to job-heavy urban markets such as Silicon Valley.

The sharp increase in housing costs in urban areas have pushed more and more workers out to the suburbs and exurbs to commute into the city. The median housing price in the San Francisco metro area has more than doubled since 2010. 2014 alone saw a 20.0% increase in median home values. People like Mr. Simmons are driving more. Single rider vehicles being on the road for longer distances and longer periods of time are doing irreparable harm to the environment and exacerbating the impact of global warming through the increased carbon emissions (Finch, 2019). With a known relation between tailpipe emissions and climate change, the increase of vehicle miles travelled (VMT) is a concerning trend.

California and the rest of the world are already becoming greatly impacted by climate change in the forms of historic fire seasons, drought, and wildlife ecosystem changes. The debate of carbon and greenhouse gas emissions (GHGs) contribution to climate change is mostly settled. Carbon and GHG emissions have a causal relationship to increased global warming. As GHGs leave the tailpipe of a vehicle and enter the earth’s troposphere, it creates a blanket and blocks heat from escaping. (NASA, 2021) We, as a society, must reduce the rate of GHGs released in our atmosphere to temper the future impacts of climate change.

A reduction in carbon is a necessary step to mitigate future risks and potentially prevent even more damage than the state has seen in recent years. The state of California has set in place measures to reduce the state’s carbon footprint. In 2018, Governor Jerry Brown set ambitious goals to stem the effects of climate change through the signings of SB100 and Executive Order B-55-18. SB100 commits California to use of 100 percent zero-carbon electricity by 2045. EO B-55-18 goes a step further and commits California to a total, carbon-neutral economy by 2045 (Roberts, 2018). Before 2045, AB32 has set goals to emit 40 percent less carbon than the 1990 levels by 2030. California has set the goals and begun the action, but cars and internal combustion vehicles (ICE) are an obstacle in meeting benchmarks. California has the tools to reduce emissions, but each tool comes with its own complexities.

To meet the goals, reducing carbon from the transportation sector will be vital. Carbon-emissions from transportation account 41 percent of all of California’s emissions, the largest of any sector in the state, and nearly 60 percent of the national transportation emissions are from single-rider vehicles (Environmental Protection Agency, 2020). California has seen an increase in vehicle miles travelled over the last twenty years but must bring creative solutions to adapt California’s size and sprawl to the requirements of the 2045 standards. (Finch, 2019) To meet the emissions benchmarks set through SB100 and AB32, how can the state best reduce carbon emissions from single-rider vehicles?

In this paper, I hope to provide new legislators a qualitative analysis of various legislative proposals that have been presented to end carbon emissions from single rider vehicles in California. In doing so, I hope to bring background and combine current literature and research, resulting in a feasibility analysis and recommendation for action. My goal is to provide enough background and context for new legislators to take their passion and hit the Capitol grounds running.

# Legal Background: Who Has The Power to Act

## The Clean Air Act

In the 1970s, pollution was a major issue throughout the country and pollutants such as carbon and sulfur were becoming a visible threat. For example, Los Angeles had a “stay-indoors” warning for much of the year due to the smog levels being over sixty percent higher than today’s levels. (Dundon, 2018) To counteract the harmful effects, Congress passed the Clean Air Act to regulate any pollutant that endangers human health and welfare and is common.

The Act kept the problems to which it applied very broad so the bounds of act could change with new knowledge or threats. While determining what is and is not a threat to regulate and protect public health is a consistent argument, the Act also provides different approaches to go about protecting public health: The first approach would be for Congress to enact new policy using the power of the Clean Air Act to regulate GHG emissions. The second approach bore out during the Clinton Administration era where House GOP Majority WHIP Tom Delay asked then EPA Administrator Carol Browner whether the EPA has the authority to regulate GHG emissions. Browner responded yes and followed up by releasing a memo that if the Legislative Branch did not act, the Clean Air Act gave the Executive Branch the authority to do so on their own. (Williamson, 2020) The implication is that not only does the CAA give the EPA the power to act to implement the law, but that the agency is required to do so.

When Congress wrote the CAA, the writers of the bill added language to ensure the Act was being used by the EPA to protect public health if presented with a threat. It ensured action by being the first law to include the Citizens Right-to-Sue. If the EPA is not doing the job the Act says the agency is required to do, citizens can sue the EPA. This is how we get to a landmark Supreme Court case which determined who has the power to protect the public against climate change and what that power is.

## Massachusetts v. EPA

Leading up to the 2000 Presidential Election, candidate and former Texas governor George W. Bush ran on a platform to regulate GHG emissions from the nation’s power plants. After his election victory, President Bush appointed former Maryland governor Christine Todd-Whitman to head the EPA and tasked her with pushing the regulations the President promised on the campaign trail. The administration backed the EPA Administrator to push a mandate based on regulating GHG emissions.

However, the promise was short-lived. Shortly into her term, EPA Administrator Todd-Whitman pushed the idea of a causal relationship between global warming and GHG emissions. The administration declined to back her statements and, without consulting the EPA, the President released a letter to congress disavowing Bush’s campaign pledge on fighting emissions through new regulation. The Administration drew the line in the sand that they would not regulate or protect against the threat of GHG emissions and climate change.

*With one stroke of the pen, the President has determined that there are more important things in the world than the rest of the world.*

– Christine Todd-Whitman on “60 Minutes”

In response to the memo which undercut Todd-Whitman, climate activists were inspired to use their Citizens Right-to-Sue power from the CAA to sue the Bush Administration’s EPA to force them to use their power from the CAA to regulate tailpipe emissions from vehicles. The EPA responded with the threat of lawsuit with a memo throwing the multiple excuses of inaction at the petition by stating they would not act because the science of climate change was still uncertain, the Department of Transportation already regulated tailpipe emissions, the EPA did not have the authority to use the CAA to restrict GHG emissions, and that the CAA did not state the EPA *had* to regulate, only that they *could*. (Environmental Protection Agency, 2003)

Citing the CAA, 12 states, three cities, and 30 interest groups sued the EPA, demanding they act in preventing GHG emissions and protect the public against the threat of climate change. Since Massachusetts was the first to petition, the lawsuit became titled and known as Massachusetts v. Environmental Protection Agency. The states were initially rebuffed by the DC District Court of Appeals after two years of consideration. The initial decision complicated the case by arguing the petitioning parties did not have standing, or a clear claim of damage incurred, from GHGs and climate change. This decision put the burden of proof on the plaintiffs to prove climate change was a clear threat and directly caused by GHG emissions from the transportation industry. Unfortunately for the EPA, their claims in their memo opened the door to the Supreme Court picking up the case by claiming the EPA did not have to follow through with the CAA if the agency did not want to do so. (Evans-Brown, 2020)

This brought about the Supreme Court case to decide whether climate change is 1) a direct threat to the public and 2) directly exacerbated by GHG emissions. Then, if both of those statements are true, the court would decide whether the EPA must act to protect the public by regulating transportation GHG emissions and if they chose not to, was it for the right reasons. (Evans-Brown, 2020)

Justice John Paul Stevens wrote the majority opinion in a 5-4 decision siding with the petitioning states and against the EPA. He rejected the EPA’s claim that the Clean Air Act’s authority to regulate “air pollution agents” did not apply to GHG emissions. The Act’s definition was written with “sweeping” and “capacious” language so the Act could evolve over time and not become obsolete. If the EPA were to continue defying its duty to regulate carbon and GHG emissions, it would need to provide evidence and consideration of “whether GHG emissions contribute to climate change.” While the EPA is required to act and enact regulation after the Massachusetts v. EPA decision, only one state can preempt the EPA and enact stricter standards on their own for new vehicles: California.

The Clean Air Act prohibits states from enacting their own emission standards for new motor vehicles, but California can apply for a waiver to enact new and stricter standards than the federal government. Under the CAA section 209(b)(1), the basis of the current waiver authorizing California to implement its emissions standards is that they are “protective of public health and welfare.” (Staff, 2018) California’s waivers can be granted if the requested standard is:

1. At least as protective as federal standards and the state’s determination of that fact was not arbitrary and capricious.
2. Meets compelling and extraordinary conditions.
3. Consistent with the Clean Air Act’s provision related to technical feasibility and lead time to motor vehicle manufacturers.

After California’s waiver is accepted, other states can follow and adopt the new standards. In the waiver process’s history, no waiver has been revoked; the only denial was shortly reversed, and waivers do not expire.

California’s ability to set its own motor vehicle emission standards was challenged in 2007 by Central Valley Chrysler-Jeep. In the case of Central Valley Chrysler-Jeep v. Goldstene, the automaker looked to block California’s power to set GHG standards to vehicles through the waiver in the Clean Air Act. Ultimately, the court ruled in favor of California through the reasoning that California’s standards, even with the addition of GHG emissions, were aimed at reducing emissions to protect from pollutants via the Clean Air Act. The court also backed their reasoning in that the waiver from the EPA gives proposed regulation from the state a federal stamp-of-approval. (Staff, 2018)

The two landmark decisions above give California the tools it needs to regulate emissions from the transportation industry. With these tools, the state can set market standards to modify behavior of the auto manufacturers and use taxation methods to have GHG emitters pay for the total cost of externalities of climate change inducing actions.

# First Lever: Taxation

California has multiple ways to tackle emissions. One way is through taxation. Taxes are effective because, in an economics sense, raising the price of a good lowers the demand and level of the good consumed. In policy decisions such as implementing a gas or carbon tax, consumers would be expected to use less gas or carbon. Taxes discourage undesirable behavior, encourage economic efficiency, and generate revenue to help cover costs endured from the good’s usage.

Figure 1 below show a supply and demand chart of a good with and without a tax. The tax in Figure 1 increases the price from P0 to P1, and as the price moves along the demand curve, consumption reduces from Q0 to Q1. This illustrates graphically how a change in price with taxation may influence the amount of a good consumed.

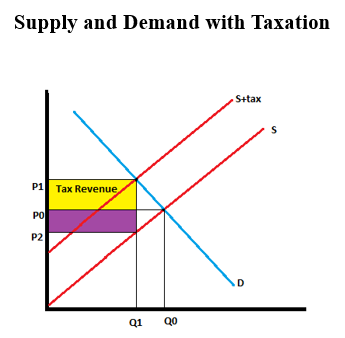


Figure 1: Supply and Demand Taxation

Taxes also help cover the cost of externalities. For example, when consumers use a gas-powered vehicle, the price paid by a consumer to operate the vehicle through registration, upkeep, and fuel does not account for the total cost to society (Economics Online, 2021). That is because of negative externalities emitted from the usage of the vehicle such as pollution in the form of smog or GHG emissions, noise, national oil dependence, traffic accidents, and more. However, others must pay for the negative externalities via climate change expenses, asthma, increased net health insurance, or higher taxes to maintain roadways. A usage tax of a good allows the consumer to pay for their total cost of usage.

A tax to help cover the costs of negative externalities is called a Pigouvian tax. An example of a Pigouvian tax is France’s tax on airplanes at its busiest airports to cover the externalities emitted in the form of noise. This tax on airplanes increases the prices of flights, reduces the demand a slight amount, and generates tax revenue distributed to help soundproof nearby homes.

California has used this method to implement a gas tax. Like other Pigouvian taxes, the goal in implementing the tax is to reduce the usage in theory, but also tax those who use more at a higher amount. California’s gas tax revenue is used to pay for transportation funds such as road repair.

Carbon taxes are an example of a Pigouvian tax implemented to reduce carbon in theory. Carbon taxes help consumers internalize their externalities. In 2013, the United Kingdom introduced a carbon tax, resulting in coal usage falling dramatically and GHG emissions in the country falling to levels unseen since the late 19th Century (Porter, 2016).

However, there are limitations of carbon taxes. If a good’s demand is inelastic, as is gasoline’s demand, the amount of tax needed to impact usage could be very high. Alternatives also have to be present for consumers to transition to as well. If no other route is available, the tax will not have the intended result of reducing consumption as needed. California has introduced various gas taxes over the last decade, but as previously discussed, the state has increased gas usage since 2010.

## Registration Tax

Outside of the United States, some countries have had more success in passing tax legislation to curb vehicle transmission. For example, Japan has levied multiple vehicle taxes and has changed its tax systems to keep up with changing behaviors. Japan implements three different taxes against drivers:

* 3 Percent tax upon purchase
* Annual emissions tax based on car type
* Weight tax

The trends in Japan have successfully changed behavior. Now, car-sharing and electric vehicles are much more popular than when the taxes above were introduced. As a result, emissions are down. In response, Japan introduced a mileage tax to cover the revenue lost from lowered emissions. Keeping an older car can also become expensive in Japan. Japan’s fuel and vehicle standards can become difficult to maintain, and registration fees increase for the age of the vehicle. In 2019, the average age of vehicles in Japan is approximately 8.65 years compared to almost 12 years in the United States (Miki, 2018).

# Second Lever: Cap-and-trade

Instead of taxing pollution and emissions outright, emissions trading or “cap-and-trade,” offers a market-based system which is more free market friendly than traditional consumption or production taxes. Emissions trading creates a market cap on pollution and sets tradable allowances that allow actors in the market to emit a certain amount of pollution. If one of the actors pollutes more or less than the limit, they can buy or sell or trade allotments from other actors in the marketplace (EPA, 2019).

Emissions trading initially came about at the federal level in the 1990s as an action to limit power plant pollution. During that time, the fear was not climate change but rather acid rain. Power plants were sending clouds of sulfur dioxide into the air, which would fall back down to earth as acid rain, damaging water sources, forests, and building across the eastern United States.

To combat acid rain, Congress had enacted 70 different bills to regulate, limit, and tax power plant pollution. With so much “command-and-control” regulation passed, environmentalists noticed frustration beginning to mount. To give people more freedom and come up with a long-term politically feasible solution, the Environmental Defense Fund (EDF) worked with the George H.W. Bush administration to come up with a market-friendly approach. An emissions trading system for power plant emissions became law with the Clean Air Act of 1990. The introduction of an emissions trading system cut acid rain in half and saves an estimated $122 billion annually in benefits from increased health and improved environments. (Conniff, 2009).

In 2006, California passed AB 32, the Global Warming Solutions Act of 2006, to reduce GHG emissions in the state to combat climate change. AB 32 required California to reduce its GHG emissions to 1990 levels by the year 2020, or a reduction of approximately 15 percent below the previously projected 2020 output. AB 32 required the California Air Resources Board (CARB) to adopt regulations to “achieve the maximum technologically feasible and cost-effective GHG emissions reductions.”

AB 32 is a mix of regulation and market-based programs implemented to reduce GHGs and invest in incentivization programs. A source of funding for the AB 32 programs is the Greenhouse Gas Reduction Fund (GGRF). In 2010, at the direction of AB 32, CARB adopted a cap-and-trade system of their own to limit GHG emissions and provide a funding source for the GGRF (California Air Resources Board, 2018).

California’s cap-and-trade program has created a market-friendly program that also allows the state to set the cap in emissions. The cap is brought down each year and brings in revenue for the state to fund programs in offsetting climate change. Carbon emissions have risen 3.5 percent since cap-and-trade began, but overall emissions have been reduced (Song, 2019). This is due in part to the whole state being connected through this market and while some can purchase more credits to pollute more, some are polluting less and there is an overall reduction of emissions.

In 2017, Governor Jerry Brown extended the cap-and-trade program until 2030 with a new goal to reduce emissions 40 percent below the 1990 levels.

# Third Lever: Supporting Electric Vehicles

While both taxes and cap-and-trade look to reduce the demand for gasoline and carbon-emitting behavior, the state can look to subsidize and incentivize desired behaviors. Incentivization can increase both supply and demand within a market and supporting the electric vehicle market is an approach California’s policy makers have taken to reduce GHG emissions. California has increased supply by making it easier to produce EVs and made it easier for consumers to buy into the EV market. California has enacted strict portfolio standards, invested heavily in subsidies, and built-out the infrastructure necessary for EVs to not only be a viable option for consumers, but take a hold of the marketplace.

EVs provide a massive upgrade over traditional gas-powered internal combustion engines (ICE) vehicles. The emissions produced from EVs are incurred from production and energy sourcing when charging the battery. Driving the vehicle produces zero tailpipe emissions. By using a “well to wheel” analysis, which provides a full life-cycle analysis of the emissions produced for an electric vehicle, EVs are over three-times more GHG efficient than ICE vehicles nationally. When isolating California vehicles, EVs become five-times more efficient than their gas counterparts. (U.S. Department of Energy, 2021)

With the potential emissions savings with EVs compared to ICE vehicles, the state has set the goal of 5 million zero-emission vehicles on the road by 2030 with 250,000 electric vehicle charging stations in place by 2025. With approximately 15 million vehicles registered, the 2030 goal would replace nearly 30 percent of the resident’s fleet. Intermediate goals have been placed to reach 1 million ZEVs by 2023 and 1.5 million by 2025. As of March 2021, the state has a little under 1 million ZEVs registered in the state. CARB and the Clean Vehicle Rebate Project (CVRP) project the state to beat the intermediate goals but fall short of the 5 million mark in 2030 by over 1 million vehicles and recommend a change to policy is required to meet the goal.

In helping to reach the goals, the state and federal governments provide purchasing assistance. The state offers the California Clean Fuel Reward and the CVRP rebate. The reward is worth up to $1,500 and lessens on a sliding scale depending on the battery size. The CVRP rebate is worth up to $7,000 is worth up to $1,000 to $7,000 based on EV type (Plug-in, ZEV, Fuel Cell) and income level. The federal government provides a tax rebate as well worth up to $7,500, but the rebate cannot exceed a buyer’s tax amount owed and the rebate decreases once a manufacturer’s sales of a particular model exceed 200,000 units sold. (California Clean Vehicle Rebate Project, 2021) In 2020, the CVRP received 46,802 applications for new EV purchases. Of that total, 6,600 were low-to-moderate income applicants. 2021 has seen double the amount of low-to-moderate income applicants than 2020. (Tamerius, Anderson, Evans, & Havel, 2021)

California has not only helped fund incentives for consumers to expand EV access, but also the necessary infrastructure to make plug-in EVs a viable option. As shown in Figure 2, California greatly exceeds any other state in total number of public charging stations. California has 32,541 stations. The next highest state is New York with 5,793.

Figure 2: Public Charging Infrastructure. (U.S. Department of Energy, 2021)

EVs dramatically reduce the emissions levels compared to a traditionally gas-fueled vehicle, but it can be unclear what the actual impact of carbon emissions is. When calculating an EV’s emission impact via a full life-cycle analysis (LCA), many factors need to be considered such as usage, energy sourcing for the consumer, energy sourcing for the manufacturer, and raw materials for production (Egede, Dettmer, Hermann, & Kara, 2015).

# Fourth Lever: Enhanced Fuel Economy Standards

Putting EVs on the road are one of the tools to manipulate the vehicle market to reach the goal of using less gas. Another tool to reach that goal is to set a fuel economy standard. In 2002, California used the power of the Clean Air Act to pass AB 1493, or what is more commonly known as the Pavley legislation. The Pavley legislation created a fuel economy standard for vehicles sold in California. Through the act, the standard would reduce GHG emissions from vehicles by 22 percent in 2012, 30 percent in 2016, and Pavley II requires a reduction of 45 percent by 2020. To gain the ability to implement the Pavley legislation, California applied for and received approval for a waiver from the EPA, but not until 2009 (California Air Resources Board, 2021). Despite being challenged in the courts, the power to implement a fuel economy standard was upheld and confirmed through the Chrysler-Jeep vs. Goldstene case.

The standard, just like cap and trade, helps reduce emissions from vehicles annually. Automakers must reduce their fleetwide emissions by 4.9 percent for cars and 4.5 percent for lightweight trucks annually. While the fuel standard helps reduce the emissions from vehicles, it only applies to new vehicles sold in the state and its benefit is slowly adopted. The standard is projected to reduce vehicle emissions by 40 percent by 2025 for vehicles sold after 2012. The emissions cap is greatly impactful in contributing to the state’s overall climate goals. CARB projects the Pavley reductions would account for 18 percent of reductions needed to meet the GHG target for 2020 (Goulder, Jacobsen, & van Benthem, 2011). Implementing fuel standards has shown to be an impactful tool and California should continue to tighten its grip and continue to increase the economy standard. However, emissions do not respect borders. When a neighboring state does not have the same emissions standard California does, California will still see the harm from another state’s pollution.

# Feasibility

Not all policy options are created equal. Policy with the purpose to reduce tailpipe emissions can face many barriers such as political opposition, lacking efficiency, or creating unintended consequences. In other words, there may be questions about whether it is feasible to establish a particular policy approaches and expect it to have the desired consequences. In this section, I will review the options discussed by analyzing potential barriers and whether the potential benefits of policy outweigh the costs.

In this feasibility analysis, I will review taxation, electric vehicles, and fuel standards. In reviewing each, I am hoping to give a policy maker a foundation for potential action so they can put their efforts where they would be most impactful and what challenges to consider when moving forward with new policy. I am leaving out cap and trade in the analysis because that lever has been shown to be a feasible solution at reducing pollution at the state level for California and on the national level with power plant emissions. Cap and trade is not the cure to climate change, but as explained in the following sections, each potential action would require nuance and most likely be a part of a multi-faceted approach to reducing vehicle emissions.

## Increasing Taxes

In California, the feasibility of using taxation to lower emissions is complicated. There are a few factors to consider, with the first being the political feasibility of getting a new tax enacted. Californians have approved various forms of increased taxation as recently as 2017, when the Road Repair and Accountability Act of 2017, also known as Senate Bill 1, was passed to increase the gas tax and use the funds for transportation improvements (California Legislative Information, 2017). Californians even rejected a proposition to repeal it in the form of Proposition 6 on the November 2018 ballot, which received 57 percent vote in opposition. However, the political feasibility to create a carbon tax is extremely difficult in California thanks to 1978’s Proposition 13.

### Proposition 13

Proposition 13 is one of the most influential policy measures in California’s history. Proposition 13 was a constitutional ballot initiative passed in 1978 which had a variety of effects aimed at reducing the impact of property taxes on owners. It capped the maximum tax rate and limited the state’s ability to reassess property tax valuations. It also froze property tax value to the 1976 assessed value and limited any reassessed value increase at two percent. But for present purposes, the most important impact of Proposition 13 was its restriction on the state’s entire ability to enact any new taxation. The proposition created a new voting requirement for state and local taxes. No longer was a simple majority vote sufficient. After its passage, the state would now require a two-thirds majority in each house of the legislature (California Tax Data, n.d.). For example, the California gas tax bill in 2017 received passed with a 27-11 and 54-26 majority in each respective house of the legislature. Despite the large majority in support of the measure, if a single vote went the other way, the gas tax would have failed. Proposition 13’s rules make the political feasibility of passing any new carbon tax much more difficult than if the state could move forward with a simple majority vote.

Proposition 13 does not only affect taxes. The anti-tax measure has lasting effects in the climate crisis. After Proposition 13 was approved, local governments began to approve commercial zoning at a higher rate because housing property taxes were frozen and not a feasible source of property tax income. Housing became a financial liability for cities and a threat to public budgets. Proposition 13 slowed housing turnover for homeowners and ultimately began making homeownership even more difficult in California. With housing viewed as a liability by planning commissions and current homeowners not moving, people began moving further and further out from urban areas (Friedersdorf, 2018). With commercial development zoning continuing to be approved, jobs remained centered in urban areas. Proposition 13 forced longer commutes, higher VMT, and higher tailpipe emissions throughout the state.

### [Washington](https://www.vox.com/energy-and-environment/2018/9/28/17899804/washington-1631-results-carbon-fee-green-new-deal)’s Failed Carbon Tax Initiatives

While carbon taxes have been successfully enacted in other countries, the political feasibility of carbon taxes in the United States has not been evident either in terms of passing or implementing carbon tax proposals. In Washington State, carbon taxes failed on the ballot in both 2016 and 2018. The two initiatives were not state measures and were decided directly by the voters, but give an idea of the political feasibility of introducing carbon taxes. The two measures were presented differently to voters: I-732 in 2016 was presented in the form of a progressive carbon tax that would be revenue neutral. The ballot initiative would have taken the revenue from the proposed carbon tax to cut taxes elsewhere. The carbon tax was also much less punitive than proposals other countries have successfully implemented. I-732 would have begun at $15 per carbon metric ton. In comparison, the UK carbon tax is set at $25 per carbon metric ton. While the proposed tax was a progressive tax in the way it reduced regressive taxes such as sales tax, it did not present enough winners for any single voter to get excited about. Liberals were moderately positive about it and conservatives hated the measure; it ultimately lost 59.3 to 40.7 percent at the ballot box.

In 2018, advocates attempted to get its carbon tax passed again with changes in how it was designed and who the revenue would serve. First, the “tax” idea was eliminated and was changed to a carbon “fee.” The wording is important in Washington. A tax revenue must go directly into the general fund while the “fee” collected from carbon emissions must be directed only where the bill states.

Using the “fee” provision, advocates in Washington ignored the revenue neutral path and earmarked the money for climate justice. On the ballot explanation, 1631 read as a ballot measure to “invest in climate justice, clean energy, clean water, healthy forests and communities.” During the campaign, the initiative’s opponents spent $20 million compared to only $5 million for those advocating for the bill. Even with this different approach, changing the language from a tax to a fee to invest in the community, the ballot initiative still lost 56.5% to 43.4%, barely achieving better results than the tax defeat two years prior. Even in one of the most climate-friendly states in the country and through two different approaches, advocates were unable to come very close to getting public approval for a carbon tax system when looking for approval via voter referendum.

### Impact of Taxation

An issue with Pigouvian tax measures is that they are inherently regressive taxes that harm the lowest economic groups the most. Forms of consumption tax such as the gas tax or a sales tax are regressive taxes that drive inequality by impacting a poorer individual’s buying power than someone who is middle or upper class. When accounting for consumption taxes, the bottom 20 percent of income earners can end up paying a 50 percent greater effective tax rate, or percentage of their income paid to taxes (Wiehe, et al., 2018). While a gas tax will prevent some from driving more, the likelihood is the lowest income bracket will be disproportionately impacted.

If done correctly, carbon taxes can be efficient and progressive. British Columbia adopted a carbon tax in 2008 which is working as-advertised and is not destroying the economy as many conservative critics would have predicted. The tax is approximately $22 per ton of CO2 and has reduced emissions by 15 percent without a significant impact on the economy. What makes British Columbia’s carbon tax special is the way it drafted to be progressive and politically feasible. The legislation returns each dollar of the carbon tax back to tax payers in the form of tax breaks. It also allowed the government to cut the corporate income tax from 12 to 10 percent and some families got a tax credit (Porter, 2016). It is unclear if similar legislation could pass in California, but British Columbia’s legislation is likely to be a referenced successful case study for any proponents pushing for a carbon tax in the state.

A potential issue with gas and carbon taxes being used as a measure to curb vehicle emissions is the inelasticity of demand for gasoline. A good such as gasoline being inelastic means a change in price will likely not have an equal change in demand. Even when the price of gasoline tumbled 28 percent in 2014, there was little to no change in consumption. Some analysis shows price would need to decrease as much as 50 percent to increase consumption by just one percent (Morris, 2014). On the other side, using a policy measure of taxing gas consumption and therefore increasing the price may not have any substantial impact to behavior. If the policy goal is to curb emissions outright, taxes might not be as effective as new potential substitute technology and could be regressive if not written correctly. If the goal is to generate revenue to help pay for the externalities of the consumption and emissions, then a gas or carbon tax could be effective in funding carbon-offsetting investments.

In the case of SB1, or the gas tax passed in 2017, the revenue gained is not allowed to be used to fight the impacts of climate change. This is because in 2018, California voters passed Proposition 69 with an 81 percent majority. This proposition amended the State Constitution to mandate revenues (approximately $5 billion annually) raised by SB1 on transportation purposes only (LAO, 2018). While the tax helps the transportation budget and increases spending in that area, it is not a viable measure to reduce GHG emissions from vehicles in the state.

## Supporting Electric Vehicles

Electric vehicles are an efficient solution because they offer a way to cut tailpipe emissions while not altering our behavior very much. Much like other tools and solutions, if not implemented and analyzed correctly, the potential benefits of supporting the market for electric vehicles could become inaccurate or overstated.

Most of the benefits of EVs rely on the energy sourcing to charge the plug-in batteries. The benefit of an EV is greatly reduced if the energy sourced for charging is itself a carbon emitter such as coal or natural gas. The break-even for EV benefit is when the sourcing energy is produced at 700g of CO2 per kilowatt hour (kwh). However, the national average for electricity production in the United States is 1kilogram of CO2 per kwh. Sourcing will not only need to be improved in California, but worldwide where some projections predict half of all electricity in 2050 to be produced via coal (Messagie, 2014).

The power generation sourcing is greatly impactful during the manufacturing process as well. When examining an EVs total emissions via a full life-cycle analysis (LCA), improved sourcing and standards can greatly improve the emissions output of an EV. For example, Tesla’s Giga-Factory in Nevada, which is designed to run on solar power, cuts CO2 output by over a third. Producing an EV in Germany produces double the CO2, which relies heavily on coal, than the same vehicle would take to produce in France (Messagie, 2014).

The benefit of an EV is also dependent on the behavior of the user. One consideration is what vehicle is being replaced by the EV. If a driver is replacing a high consumption vehicle such as a Ford F-150, the EV is going to provide a significant GHG efficiency improvement. However, countries like Japan see less benefit on a whole where smaller, highly efficient ICE vehicles have become popular.

Projections of benefit also depend how much the EV is being driven. Assumptions have been consumers are purchasing EVs to be their primary vehicle and EVs present a substitute for ICE vehicles, but that may not be the case and therefore the replacement benefit might be less than estimated. Recent data from PG&E shows households are charging their EVs enough to drive approximately 5,300 VMTs annually. The data estimates are significantly lower than state estimates and the VMT of a standard ICE vehicle (9,053), suggesting EVs might not be a primary substitute (Burlig, Bushnell, Rapson, & Wolfram, 2021). If so, the adoption rate and current projected benefit of EVs might be exaggerated. If people are buying an EV, but still using an ICE vehicle as their primary vehicle, purchase of EVs does not equal adoption.

## Enhancing Fuel Economy Standards

Despite CARBs assessment of fuel economy standards providing California 18 percent of the reductions needed to meet the 2020 GHG target, there might be flaws in the effectiveness of Pavley limits. In the 14 states that became “Pavley” states, emissions dipped significantly within those states. However, the effectiveness becomes more complicated when accounting for the other states.

The Pavley limits are stricter on emissions than federal limits. Due to the interaction with the federal corporate average fuel economy (CAFE) standards, “leakage” occurs and other states begin emitting more GHGs. This dynamic happens because at the federal level, CAFE limits will monitor a manufacturer’s sales across their whole fleet nationally. In 2016 the federal standard for domestic passenger vehicles was 36.5 miles per gallon (mpg). With this standard, all domestic passenger vehicles sold by a manufacturer in 2017 would need to meet a national average of 36.5 mpg. If the Pavley standard in 2016 required 43.4 mpg, the manufacturer would go above and beyond the CAFE limit by just meeting the minimum Pavley limit, and therefore allow the fleet sold in non-Pavley states to have a much worse efficiency with the wiggle room created in the 14 states. Unless there is a federal standard that provides the strictest standard, California’s efforts are undone by non-adopting states.

Fuel standards have unintended consequences within a state as well. Leakage can occur through the used car market. In theory, a stricter standard will lead to more expensive new cars. A household might decide to hold on to their less efficient used car for longer than they would have at a lower price point, which then inflates the supply of used vehicles in operation.

While fuel standards are easier to pass than a carbon tax, they are not as efficient and can end up being more regressive than a carbon tax. U.S. fuel standards are mildly progressive on the surface, as higher income households bear most of the costs of new vehicle purchases, but when accounting for the used vehicle market, economists have found standards flip and show to be mildly regressive (Davis & Knittel, 2016).

# Alternatives Analysis

By 2050, 70 percent of the world’s population is projected to live in a city. While the focus at the state level is pulling levers to influence markets and reduce unwanted behavior, the way our local environments and cities are built encourage driving. In the United States, our cities are built in a way that necessitates driving through limited public transportation and sprawl. We fall behind most European cities in building a green infrastructure to encourage bicycling, walking, and utilizing potentials of public transport. It is no surprise the United States ranks second in total CO2 emissions and second in CO2 emissions per capita (Cooper, 2019). Especially in California, life is dependent on driving. Californians, on average, drive 30 minutes to work, which ranks as sixth highest in the country (United States Census Bureau, 2019).

The messaging to reducing GHGs and fighting climate change often revolves around individual actions. Historically, environmental protection public service campaigns such as the plastics industry-funded “Keep America Beautiful” campaign successfully put the perceived responsibility protecting the environment on the individual (Dunaway, 2017). The climate crisis is no different. While individuals can make certain decisions to make incremental reductions of their carbon footprint, people’s behavior is often a reflection of their environment and social norms.

A large contributing factor to Californian’s carbon footprint is where we build housing. Despite being home to approximately 45 percent of the country’s population, suburban households account for 50 percent of the GHG emissions. People in cities tend to drive less and use public transportation more where available. Some suburban counties in California account for more than double the national average. The average carbon footprint per household in California is 45 tons of CO2 emissions (tCO2e) annually. However, in areas such as Burlingame (a Bay Area suburb) and Loomis (a Sacramento suburb), the footprint increases to over 60 tCO2e. Comparatively, many households in zip codes in Oakland and San Francisco have an average of less than half of the average state emissions. Transportation is a major factor in the suburban increases. Of suburban homes, transportation emissions are 2.5 times higher than urban ones (Jones & Kammen, 2013).

Suburbs, sprawl, and low-density cities are the product of the policies in place that have contributed to the housing crisis in California which is also connected to transportation GHG emissions. California has many tools to prevent increased density in cities. Neighborhood groups often prevent construction of additional housing projects with the threat of a CEQA lawsuit. Often the goal is not to directly use CEQA to stop a project, but rather to draw out costs of construction until developers give up on the project (Sabelhaus, 2018). Development fees such as those associated with CEQA can greatly increase the cost per housing unit. California has seen development fees rise by 2.5 percent from 2008 to 2015 in comparison to a 1.2 percent decrease nationally. In the Sacramento region, a typical single-family home costs $21 thousand in development fees (Mawhorter, Garcia, & Raetz, 2018). When developers run into costly obstacles, housing prices go up through development costs and lack of supply. As a result, metro regions grow in land mass which creates larger commute times. As shown in Figure 3 below, the Northern California region’s main job centers are the San Francisco Bay Area and Sacramento, but the commute times are high across the entire region.

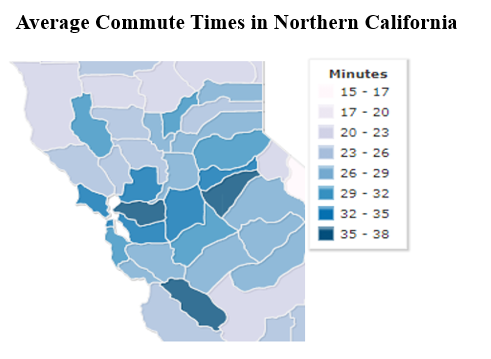


Figure 3: Average Commute Time. (Mundi Index, 2020)

One solution at the local level to cut transportation emissions that is even more carbon efficient than EVs is increasing bicycle usage. To reduce GHG emissions, the state must promote non-vehicle modes of transportation such as bicycling. Major cities in Europe have adopted mass-bicycle usage and have a much lower level of GHG transportation emissions because of it. For example, Copenhagen bicycle riding is so prevalent, it has more bicycles than cars in the city. In Denmark as a whole, 16 percent of all commutes are done by bicycle. In California, San Francisco has the most bicycle commuters in the state, but that group only accounts for 3.4 percent of all commuters in the city. As Figure 4 shows, most major California cities have less than one percent of their commuters bicycling to work (United States Census Bureau, 2019).

Figure 4: Portion of Bicycle Commuters in CA City (United States Census Bureau, 2019)

# Conclusion

After reviewing the options California can take to reduce GHG emissions from single passenger vehicles, the state needs to continue a wholistic approach and a potentially important impact may come from systematic changes at the local planning level to encourage less driving and at the federal level to reduce effects such as leakage.

The issues we are facing are both larger and smaller than California. California can be the leader of a climate movement at the state level, but local planning and sweeping federal policy would be the most effective at reducing driving and reducing the leakage discussed with fuel standard policy. California can enact policy to promote better habits or cut down on undesired ones, but its residents suffer from sprawl resulting in long-distance driving at a regular occurrence. Introducing new technology such as EVs help reduce emissions, but the energy for battery charging and the energy required for manufacturing can reduce the benefits of EVs if they are sourced from natural gas or coal. Creating strict state fuel economy standards helps emissions in the state, but without a strict federal guideline, California’s good intentions allow other states to behave worse than they would be able to without our actions.

California needs to keep on their path of implementing cap and trade, creating a fuel standard, and promoting EVs. Each of these are necessary as the solution to the climate crisis will not come from a single approach. Even with all of these policy tools helping, systematic change is needed. Ultimately, the large-scale change would need to come from a changing of urban and rural planning environments where driving at all is not always the best option to get from A to B. Substitute options such as bicycles, public transit, walkable communities, and higher density cities would all contribute greatly to reducing tailpipe emissions.

One of the most important barriers to creating the systematic change we need is Proposition13. Proposition13 connects the climate crisis, housing crisis, and equity crisis in California and must be modified. As previously discussed, Proposition13 does not allow for cities to provide a housing-first planning approach and create higher density. With continued low density, sprawl and high VMT will continue in the state. If Proposition13 is changed, cities and states can begin the systematic change necessary to reduce emissions.

California should continue its path current path and continue to tighten emissions limits, but to provide a sustainable society that does not rely on VMT and high energy consumption, a continued approach to attacking climate change with create solution will be required. Much of the pledges the state and nation take lack a roadmap and require for policy makers and practitioners to come up with the solutions. Some of the solutions have been proposed and implemented. Cap and trade works. Carbon taxes and fuel standards can work if implemented correctly. EVs can reduce emissions if they are adopted at a large scale and the energy is produced correctly. In the end, we have a responsibility to continue to develop and innovate emissions-reductions solutions, continue on the path, but also work to push greater responsibility on local and national-level solutions to go hand-in-hand with California’s.

# References

Burlig, F., Bushnell, J. B., Rapson, D. S., & Wolfram, C. (2021). Low Energy: Estimating Electric Vehicle Electricity Use. *NBER Working Paper Series*.

California Air Resources Board. (2018, September 28). *AB 32 Global Warming Solutions Act of 2006*. Retrieved from CA.gov: https://ww2.arb.ca.gov/resources/fact-sheets/ab-32-global-warming-solutions-act-2006

California Air Resources Board. (2021). *California's Greenhouse Gas Vehicle Emission Standards under Assembly Bill 1493 of 2002 (Pavley)*. Retrieved from CA.gov: https://ww2.arb.ca.gov/californias-greenhouse-gas-vehicle-emission-standards-under-assembly-bill-1493-2002-pavley

California Clean Vehicle Rebate Project. (2021, April). *State and Federal Electric Vehicle Incentives*. Retrieved from https://cleanvehiclerebate.org/eng/ev/incentives/state-and-federal

California Legislative Information. (2017, May 1). *Senate Bill No. 1*. Retrieved from California Legislative Information: https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill\_id=201720180SB1

California Tax Data. (n.d.). *What is Proposition 13*. Retrieved from California Property Tax Information: https://www.californiataxdata.com/pdf/Prop13.pdf

Camila, D. (2018, September 10). California Sets Goal Of 100 Percent Clean Electric Power By 2045. *NPR*.

Conniff, R. (2009, August). The Political History of Cap and Trade. *Smithsonian Magazine*.

Cooper, L. (2019, January 31). *Is the solution to climate change better urban planning? The role of urban infrastructure in driving individual carbon footprints*. Retrieved from The Henry M. Jackson School of International Studies at the University of Washington: https://jsis.washington.edu/news/is-the-solution-to-climate-change-better-urban-planning-the-role-of-urban-infrastructure-in-driving-individual-carbon-footprints/

Davis, L. W., & Knittel, C. R. (2016). Are Fuel Economy Standards Regressive? *National Bureau of Economic Research*.

Dunaway, F. (2017, November 21). The 'Crying Indian' ad that fooled the environmental movement. *Chicago Tribune*.

Dundon, R. (2018, May 23). *Photos: L.A.’s mid-century smog was so bad, people thought it was a gas attack*. Retrieved from Timeline: https://timeline.com/la-smog-pollution-4ca4bc0cc95d

Economics Online. (2021). *Market Failures: Negative Externalities*. Retrieved from Economics Online: https://www.economicsonline.co.uk/Market\_failures/Externalities.html#:~:text=A%20negative%20externality%20is%20a,consequence%20of%20an%20economic%20transaction.&text=Externalities%20commonly%20arise%20in%20situations,been%20allocated%2C%20or%20are%20uncer

Egede, P., Dettmer, T., Hermann, C., & Kara, S. (2015). Life Cycle Assessment of Electric Vehicles – A Framework to Consider. *Science Direct*, 233-238.

Environmental Protection Agency. (2003). *Control of Emissions From New Highway Vehicles and Engines.* Washington D.C.: EPA.

Environmental Protection Agency. (2020, July 29). *Fast Facts on Transportation Greenhouse Gas Emissions*. Retrieved from United States Environmental Protection Agency: https://www.epa.gov/greenvehicles/fast-facts-transportation-greenhouse-gas-emissions

EPA. (2019, December 17). *What is Emissions Trading?* Retrieved from United States Environmental Protection Agency: https://www.epa.gov/emissions-trading-resources/what-emissions-trading

Evans-Brown, S. (2020, June 4). *Massachusetts v EPA*. Retrieved from Outside/In Radio: http://outsideinradio.org/shows/massvepa

Finch, M. (2019, March 18). Remote workers and super commuters are on the rise – and they probably make more than you. *Sacramento Bee*.

Friedersdorf, C. (2018, June 4). Op-Ed: After 40 years, Proposition 13’s failures are evident. *Los Angeles Times*.

Goulder, L. H., Jacobsen, M. R., & van Benthem, A. A. (2011). Unintended consequences from nested state and federal regulations: The case of the Pavley greenhouse-gas-per-mile limits. *Journal of Environment Economics and Management*, 187-207.

Jones, C., & Kammen, D. M. (2013). Spatial Distribution of U.S. Household Carbon Footprints Reveals Suburbanization Undermines Greenhouse Gas Benefits of Urban Population Density. *Environmental Science and Technology*, 895-902.

LAO. (2018). *ACA 5 (Resolution Chapter 30, Statutes of 2017), Frazier. Motor vehicle fees and taxes: restriction on expenditures: appropriations limit.* Sacramento: Legislative Analyst's Office.

Massachusetts Et Al. v Environmental Protection Agency Et Al, 05-1120 (Supreme Court of the United States April 2, 2007).

Mawhorter, S., Garcia, D., & Raetz, H. (2018). *It All Adds Up: The Cost of Housing Development Fees in Seven California.* Berkeley: Terner Center for Housing Innovation at UC Berkeley.

Messagie, D. M. (2014). *Life Cycle Analysis of the Climate Impact of Electric Vehicles.* Transport and Environment.

Miki, R. (2018, November 28). Japan to Overhaul Auto Taxes as Industry Transforms. *Nikkei Asia*.

Morris, M. (2014, December 15). *Gasoline prices tend to have little effect on demand for car travel*. Retrieved from U.S. Energy Information Administration: https://www.eia.gov/todayinenergy/detail.php?id=19191#:~:text=Gasoline%20is%20a%20relatively%20inelastic,have%20little%20influence%20on%20demand.&text=The%20price%20elasticity%20of%20motor,to%20raise%20automobile%20travel%201%25.

NASA. (2021, April 15). *Causes and Facts*. Retrieved from NASA Global Climate Change: https://climate.nasa.gov/causes/

Porter, E. (2016, March 1). Does a Carbon Tax Work? Ask British Columbia. *New York Times*.

Roberts, D. (2018, September 12). California Gov. Jerry Brown casually unveils history’s most ambitious climate target. *Vox*.

Sabelhaus, P. (2018, October 5). Secretary and Executive Director, California Affordable Housing Council. (C. Skidmore, Interviewer)

Song, L. (2019, November 15). Cap and Trade Is Supposed to Solve Climate Change, but Oil and Gas Company Emissions Are Up. *Propublica*.

Staff, E. (2018, June 19). California, CAFE Standards, and the Energy Policy and Conservation Act. *Harvard Environmental & Energy Law Program*.

Tamerius, J., Anderson, J., Evans, C., & Havel, K. (2021). *Preliminary CVRP Projections: 2021-2023: Update 1.* Center for Sustainable Energy.

U.S. Department of Energy. (2021). *Alternative Fuels Data Center*. Retrieved from Energy Efficiency & Renewable Energy: https://afdc.energy.gov/vehicles/electric\_emissions.html

United States Census Bureau. (2019). *American Community Survey.* Retrieved from United States Census Bureau: https://www.census.gov/acs/www/data/data-tables-and-tools/ranking-tables/

Wiehe, M., Davis, A., Davis, C., Gardner, M., Gee, L. C., & Grundman, D. (2018). *WHO PAYS? A Distributional Analysis of the Tax Systems in All 50 States.* Washington DC: The Institute of Taxation and Economic Policy.

Williamson, E. (2020, March 12). *How a Supreme Court Case Turned on Professor Jonathan Cannon’s Memo*. Retrieved from University of Virginia, School of Law: https://www.law.virginia.edu/news/202003/how-supreme-court-case-turned-professor-jon-cannons-memo