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DIFFUSION OF INNOVATION OF ELECTRIC VEHICLES IN CALIFORNIA AND TEXAS: POLICY COMPARISON

Bachelor's thesis

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I hereby declare that I have compiled the thesis independently and all works, important standpoints, and data by other authors have been properly referenced and the same paper has not been previously presented for grading.

The document length is 8,192 words from the introduction to the end of the conclusion.

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ABSTRACT

Although electric vehicles (EVs) have soared in popularity in the last decade, the 5% threshold of adoption, which has been found in other countries to trigger rapid EV adoption, was only surpassed in the U.S. in 2022. While U.S. states like California and Texas, as well as the Federal Government have introduced policies to accelerate the adoption curve, the diffusion of EVs varies significantly among the mentioned states as California has a per-capita EV ownership rate of close to 5 times higher than Texas' rate.

This paper aims to answer the research questions, "What are the specific EV monetary incentives and grants offered by local governments and businesses in California and Texas, and how do they differ?" and "What initiatives have been implemented by state and local governments to increase EV adoption among disadvantaged communities in California and Texas?".

This comparative study applies diffusion of innovation (DOI) and technology acceptance model (TAM) to analyze the variance in EV adoption between the two states from a policy perspective, as one of the first studies to do so, through a qualitative thematic content analysis of relevant policy documents. It highlights nine key findings to explain this variance and proposes an additional construct to the DOI, "Mandatory" which covers the policy influence on the adoption of new innovations. It puts forward several recommendations for legislators to improve EV adoption at government, companies and societal levels.

The study used a qualitative approach through thematic content analysis of secondary data. The data was collected from federal, state and local government websites and databases. The first level codes were identified and subsequently grouped into themes. These themes were further organized according to the target group of the relevant policies: individuals, private entities, and state and local governmental agencies.

Keywords: Electric vehicle adoption, electric vehicle policy, innovation adoption, diffusion of innovation, technology acceptance model.

INTRODUCTION

In recent years, Electric Vehicles (EVs) have grown in popularity in the U.S. as society becomes more environmentally conscious. Nonetheless, the adoption of this technology is still in its early stages with the country surpassing the 5% threshold for new fully electric-powered car sales for the first time in 2022 (Randall, 2022). Furthermore, the federal government and several U.S. states have introduced laws to incentivize consumers to opt for EVs instead of gasoline-powered vehicles and accelerate the adoption curve (The United States Government, 2022).

However, in some states the adoption of EVs has risen sharply while in others this trend has been moderate; it must then be understood why the adoption of EVs in a state like Texas is 5 times lower per capita when compared to neighboring California, for example (Alternative Fuels Data Center, 2022).

Although current literature covers the effects of incentives on EV adoption (Clinton et al., 2019) as well as the comparison of EV policies between countries (van der Steen et al., 2015), few, if any, focus on comparing the EV policies between U.S. states and how they influence adoption. Wee et al. (2018) analyzed the effectiveness of monetary and non-monetary policy incentives on EV adoption by using data from the 50 U.S. states. Moreover, while they did focus on policies at the state level, their study primarily analyzed incentives and did not offer a more in-depth EV policy comparison between two states.

The paper aims to understand how the policy differences between California and Texas are affecting adoption of EVs and address the current research gap on the subject by comparing the states' EV policies.

The author's interest is particularly related to finding out why is it that despite being first and second place in EV sales and inventory, California has a per capita EV ownership rate of 0.014 compared to Texas' per capita rate of 0.0027 (Alternative Fuels Data Center, 2022).

Specifically, the study focuses on the different EV laws and incentives as well as overall state government mandates affecting EV adoption. It aims to answer the following research questions:

1. What are the specific EV monetary incentives and grants offered by local governments and businesses in California and Texas, and how do they differ?
2. What initiatives have been implemented by state and local governments to increase EV adoption among disadvantaged communities in California and Texas?

A qualitative approach is followed for data collection and analysis, using secondary data from governmental (federal and state) such as websites, published strategies and reports.

This research paper contributes to literature by addressing the research gap regarding EV policy comparison between California and Texas.

In this study, the introduction is followed by a comprehensive theoretical background, which covers different studies regarding how factors and policies affect EV adoption. Specifically, this part focuses on theoretical frameworks such as the theory of Diffusion of Innovation (DOI) and the Technology Acceptance Model (TAM) and how they were applied in practice to predict EV adoption. After the methodology, findings are presented and the foundation is set for the last chapter, the conclusion. In the conclusion part, this study discusses the relevance and practical implications of the findings and compares them with previous academic findings. Lastly, the author explains the research limitations, and provides recommendations for future research.

1. THEORETICAL BACKGROUND

This section provides an overview of the diffusion of innovation model, which is the focus of this research. Moreover, it reviews current literature on electric vehicle adoption enablers and challenges as well as the policy context of electric vehicles.

1.1. Diffusion of innovation and technology acceptance model

To understand how societies accept and incorporate an innovation into their lives, researchers use theories to guide their studies and establish procedures that can be applied in future research. One such theory is the diffusion of innovation theory.

The diffusion of innovation theory (DOI), which was developed by E.M Rogers in 1962, aims to explain how a new technology is adopted or "diffuses" over time by a certain population. In the book "An integrated approach to communication and Theory", Rogers et al. (2014) take a deep dive into diffusion of innovation studies by dozens of authors and highlight the different directions of diffusion research, as well the approaches used to conduct it. Additionally, the authors go over real-life studies of diffusion research in the United States and to help the reader understand the adoption stages of different technologies by society. Finally, they conclude that for successful understanding of the adoption of future technologies, researchers must focus on the collective and study communities and organizations, rather than individuals.

Furthermore, DOI theory states that whether an innovative product is adopted by the masses or not relies on 5 perceived characteristics. These are compatibility (whether the adopter perceives an innovation to be "consistent" with their values and current needs), relative advantage (whether the adopter perceives an innovation to be an upgrade over its predecessor), triability (how much an adopter can experiment with an innovation for a limited period of time), complexity (whether the adopter perceives an innovation to be difficult to use), and observability (whether the adopter can see the results of an innovation) (Rogers, 2004, as cited in Xia et al., 2022).

Similarly, the technology acceptance model (TAM) has been used to study the diffusion of new technologies (Lee et al., 2011). Developed by Fred Davis in 1986, TAM focuses on two primary factors that influence an individual's intention to use new technology: perceived ease of use and perceived usefulness (Davis, 1989). The former (perceived ease of use) refers to an individual's expectation that using a new technology will be easy and require little effort while the latter (perceived usefulness) refers to an individual's expectation that using a new technology will help them perform better, as noted by Davis in his research. It must be noted that an individual's decision to adopt an innovation is ultimately affected by their entourage (Dabic et al., 2011).

When trying to understand adoption of EVs, previous research has also focused on consumer acceptance of a new habit, which changes the way in which people charge their electric vehicles. Moreover, Wang et al. (2022) use the technology acceptance model (TAM) to analyze the factors influencing consumer acceptance of electric vehicle charging scheduling, which requires them to charge their vehicles at a set time for energy optimization and not whenever they decide to. Based on their findings, the authors suggest governments incentivize people to accelerate the adoption of electric vehicle charging scheduling and that measures are taken to educate them about electric vehicles and their importance.

Talebian et al. (2018) suggest a different approach to the diffusion of innovation theory by combining it with agent-based modeling to forecast the adoption of connected autonomous vehicles or CAVs. The authors remind the reader that for a person to adopt a new technology, CAVs in this case, their social circle plays a key role because it is who they will consult with before deciding. Specifically, whether their circle is composed of people who have had positive or negative experiences with the new technology plays a big factor in influencing them. Through extensive research and surveying, the authors conclude that marketing has a limited impact when it comes to significantly boosting the diffusion of CAVs, thus emphasizing the importance of the adopter's social network.

In their study, Iskin et al., (2013) take a deep dive into diffusion of alternative energy innovation studies by dozens of authors and highlight the different directions of diffusion research, as well the approaches used to conduct it. Additionally, the authors go over real-life studies of diffusion research in the United States and other countries to help the reader understand the adoption stages of different alternative energy technologies by society.

Furthermore, another study uses the Bass diffusion model, a differential equation created by Frank Bass, to predict when consumers of four different economic classes in California will adopt plug-in electric vehicles or PEVs. Using the Bass diffusion model, the results forecasted 'mid to high income' and 'middle income' clusters will have to significantly increase their adoption of PEVs for the market to reach its full potential (Lee et al., 2019). Furthermore, another study found the Bass model is a good predictor of adoption of new technologies and discussed in previous literature where the model was used to forecast adoption trends (Daim & Suntharasai, 2009).

In another study, Xia et al. (2022) use the diffusion of innovation theory to study the factors affecting electric vehicle (EV) adoption through a survey. The authors develop a research model which focuses on perceived compatibility, perceived complexity, and perceived relative advantage to understand consumer adoption of EVs. Furthermore, this research paper suggests that the research model can accurately predict consumer behavior when it comes to EV adoption.

However, in their research, Min et al. (2018) mention previous studies that suggest the technology acceptance model works best when combined with other theories. Which is why they combine the technology acceptance model with the diffusion of innovation theory to analyze consumer adoption of a ride-hailing mobile application, Uber. The authors question the effectiveness of using the technology acceptance model on its own to study the adoption of a new technology. After examining their survey responses, the study concludes that there is a significant relationship between the factors used in their diffusion of innovation and technology acceptance models. Similarly, Phan and Daim (2011) expanded TAM by integrating factors affecting mobile service adoption, suggesting TAM works best when combined with other theories from literature.

1.2. EV enablers and challenges for adoption

When it comes to analyzing the diffusion of a new technology, local governments and policymakers must be aware of the factors encouraging and holding consumers back from adoption. They must adjust their approaches using consumer's feedback if there is resistance towards innovation (Daim et al., 2008).

Regarding a serious challenge for electric vehicle (EV) adoption, Noel et al. (2018) focus on range anxiety, which is a common concern for consumers that believe an EV will not travel great distances. However, the authors argue that existing literature on range anxiety is inconclusive and as a result they combined Hirschman's Rhetoric of Reaction theory with the diffusion of innovation theory to better analyze range anxiety and its effect on EV adoption. Furthermore, this research paper suggests policy makers should prioritize educating consumers about the range of EVs instead of investing significant funds in EV charging infrastructure, which they argue would not address the problem of range anxiety.

Nonetheless, other studies have focused on the EV adoption incentives. In their research paper, Clinton et al. (2019) analyze the effect financial incentives have on consumer battery electric vehicle (BEV) adoption using a national database. discover that incentives in the form of purchase rebates of at least $1000 lead to an increase in BEV registration of between 8% and 11%. However, their results indicate that subsidizing BEVs has a negative emissions effect in all states except California and Texas. Moreover, the authors conclude that while incentives succeed in boosting consumer adoption of EVs, they result in an increase of emissions, which must be taken into account when analyzing their cost-effectiveness.

Similarly, Jenn et al. (2018) study electric vehicle (EV) purchase incentives and their effect on stimulating consumer adoption. Additionally, they focus on the importance of providing EV owners access to special lanes in highways where there is less traffic, also known as high-occupancy vehicle (HOV) lanes. Regarding adoption enablers, the authors find that purchase rebate incentives result in close to a 3% increase in EV adoption per $1000 offered while access to HOV lanes increases adoption by close to 5%. Nonetheless, this research paper concludes that policymakers should educate consumers about EV incentives to boost adoption and that those in states with high traffic congestion should prioritize HOV lane access.

Furthermore, another study finds that tax credits and rebates have a significant impact on BEV adoption (Narassimhan & Johnson, 2018). Moreover, the authors' results are in line with previous studies' findings that the availability of BEV charging infrastructure significantly influences adoption of BEVs.

To get a broader perspective of EVs, a research paper by Yozwiak et al. (2022) focuses on both the enablers and the barriers to EV adoption as well the potential approaches to mitigate concerns and succeed in the diffusion of EVs. Regarding incentives, the authors point out the importance of building EV charging infrastructure in low-income communities, offering credits for the installation of at-home charging equipment, and extending the benefits of purchasing rebates to used cars to minimize emissions. In contrast, they argue the three main challenges to EV adoption are high prices, range anxiety, and a lack of charging station availability.

Supporting the findings of previous research on the positive effects of EV charging infrastructure, the U.S. Government (2022) passed a legislature to build a national charging infrastructure made up of more than 500,000 stations across the 50 U.S. states and Puerto Rico by the year 2035. Furthermore, the plan will offer monetary incentives for consumers to afford EVs and reveals plans with car manufacturers to achieve the goal of making EVs represent 50% of total car sales by 2030.

2. RESEARCH METHODOLOGY

2.1. Policy context of EVs in Texas and California

While California and Texas are similar in many aspects like having a large economy (U.S. Bureau of Economic Analysis, 2022), nearly identical unemployment rates (U.S. Bureau of Labor Statistics, 2022), a large population (*United States Census Bureau*, 2020), and share a border in the Western region, they vary significantly in how they are managed by their respective governments.

Namely, the difference in the size of their governments. For example, local governments in Texas spent $10,024 per resident compared to $16,105 spent by their California counterparts. These expenditures are mainly in the areas of education, social services, and public safety. Similarly, government revenues per resident were $9,997 and $16,879 respectively. One reason for this stark contrast is the fact that California has a high-tax, high-public-spending approach while Texas has a low-tax, low-public-spending approach. (Duggan & Olmstead, 2021).

In their study, Duggan and Olmstead (2021) point out that Texas has the fifth-lowest electricity prices while California has the third-highest prices among the 50 U.S. states. Also, they highlight that although the states have similar levels of renewable energy production, California has clear policies that encourage and target emission reductions, including those from gas-powered vehicles, while Texas has no such policies or targets in place.

While not many academic articles focus on the EV policies of Texas or California, Kuzio et al. (2021) provide an economic tool for policymakers in Texas to assess the benefits of investing in EV charging infrastructure while considering the associated costs. The authors highlight key metro areas in Texas where they forecast fast EV adoption based on current EV policies like Austin. However, they also predict that small urban areas like Tyler, Texas will experience a slow EV adoption and argue the need for more investment in charging infrastructure to meet the city's needs. Furthermore, the research paper concludes that regardless of the size of the metro area in Texas, the rewards of investing in charging infrastructure will exceed the associated costs.

2.2. Research design

A mix of exploratory and explanatory qualitative approach was followed in this paper to answer our research questions, as there is a lack of previous studies addressing this topic. This help us fulfill the primary aim of this study which is to identity EV policies relevant to California and Texas, analyze the key differences, and discuss how they affect the variance in EV adoption among these states.

This explanatory approach aims to build an understanding how EV policies in California and Texas compare to each other while considering federal EV policies. Also, explanatory analysis helps to establish connections between the data among through observed patterns (Gelo et al., 2008).

Similarly, the exploratory approach was used to examine current theoretical constructs and determine whether EV policies fit into them. Thus, it served as the basis to determine whether new constructs were needed to properly classify data for qualitative analysis (Guetterman et al., 2015).

This study used secondary data on EV policies and laws, as well as federal, state and county mandates related to EVs and their supporting infrastructure. Moreover, the thematic analysis method was used to classify repeated policies into themes. We relied on official U.S. government federal and state databases and websites as the main sources for data collection to guarantee the correctness and veracity of the analyzed data and thus the subsequent findings and conclusions produced in this study. These are shown on the table below:

Table 1. Federal websites and databases

Name	URL
Alternative Fuels Data Center (California)	https://afdc.energy.gov/fuels/laws/ELEC?state=ca
Alternative Fuels Data Center (Texas)	https://afdc.energy.gov/fuels/laws/ELEC?state=TX

California Air Resources Board	https://ww2.arb.ca.gov/our-work/programs/truck-and-bus-regulation/about
Federal Highway Administration	https://www.fhwa.dot.gov/policyinformation/tmguide/tmg_2013/vehicle-types.cf
Texas Department of Motor Vehicles	https://www.txdmv.gov/dealer/franchise
The United States Government official website	https://www.whitehouse.gov/briefing-room/statements-releases/2022/06/09/fact-sheet-biden-harris-administration-proposes-new-standards-for-national-electric-vehicle-charging-network/
U.S. Bureau of Labor Statistics	https://www.bls.gov/web/laus/laumstrk.htm
U.S. Bureau of Economic Analysis	https://www.bea.gov/data/gdp/gdp-state
U.S. Census Bureau	https://www.census.gov/popclock/

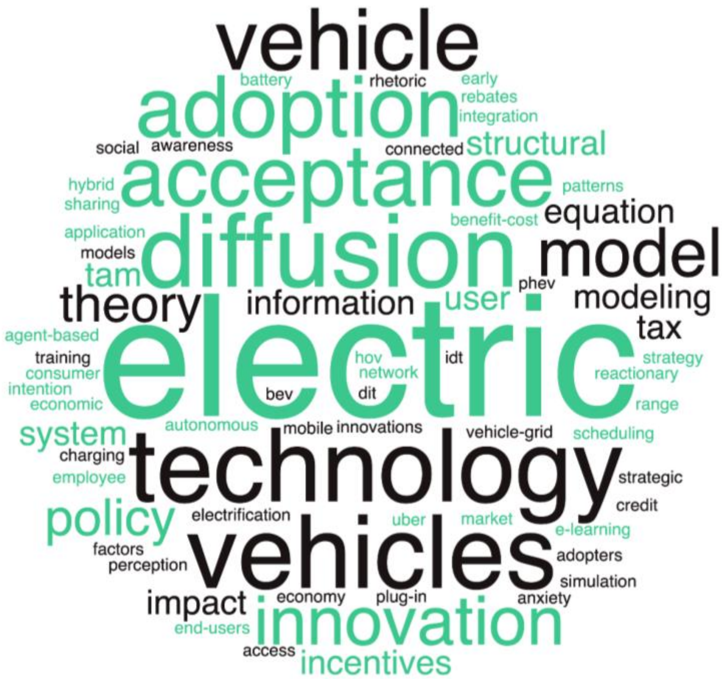
Source: Author

It must be noted that only the Alternative Fuels Data Center was used to gather EV policies in California and Texas, which were the primary source of the findings. The rest of sources were mainly used to collect data that provided context to the study to support the introduction, literature review, and discussion.

2.3. Data collection and processing

To get a clearer picture of the main ideas related to EVs and the policy context, the author collected the keywords from the articles reviewed as part of the literature background of this study that are related to the topic of the study. Then used them to search on US government federal and state websites and databases to elicit in-scope policies and laws. The search keywords are demonstrated in the following in a word cloud figure:

Figure (1): Search keywords on US government portals



It must be noted that while some of these keywords are similar to the themes that were developed during data analysis, however, they were only used as starting points to guide thinking process. Also, keywords were "cleaned" to remove redundancies and focus on those that were related to our research aim and topic. This helps illustrate repeating patterns and a more accurate representation of the literature review (Yang et al., 2021).

To organize the data collection and archiving, policies were categorized into three themes, after an initially skimming through them: "Individuals," "Businesses and private entities," and "Governments and public entities." These are presented in the tables below with the two main subthemes.

Table 2. Incentives and mandates for individuals, businesses, and local governments

Monetary incentives	● Rebates and grants to incentivize individuals, businesses, and local governments to purchase EVs and charging infrastructure. Includes special incentives geared towards low-income residents and disadvantaged communities. ● Rebates and grants incentivizing local governments and agencies to build EV charging infrastructure.
Mandates	● Standards and requirements that state and local governments, businesses, and individuals must abide by. This also includes policies requiring businesses and government agencies to reduce emissions and preserve the environment. ● EV-related reports and assessments that must be submitted by state and local government agencies.

Source: Author

The table outlines policies to encourage EV adoption in the US. These policies fall into two categories: monetary incentives (rebates and grants) and mandates (standards and requirements). Monetary incentives target individuals, businesses, and local governments to purchase EVs and charging infrastructure, while mandates focus on reducing emissions and preserving the environment through compliance requirements and EV-related reporting.

2.4. Data analysis

A total of 162 EV policies were analyzed, with 142 from Californian jurisdiction and 22 from Texan jurisdiction. Moreover, a document (linked in Appendix 1) with the policies and their summaries extracted from the Alternative Fuels Data Center was created and used for the author to make data analysis simpler.

Specifically, EV policies were classified using thematic analysis method (Clarke & Braun, 2014, as cited in Neuendorf, 2018). This method involves six steps:

1. Familiarizing oneself with the data

2. Generating initial codes that relate to data that can answer the research question(s)
3. Searching for themes within the codes
4. Reviewing the themes until they accurately represent the data and help answer the research question(s)
5. Defining and naming the themes
6. Producing a report where the thematic analysis is related to the existing literature.

This study relies on thematic analysis because it is considered one of the main methods for analyzing qualitative data (Maguire & Delahunt, 2017). This is because EV policies from Texas, California, and the federal government are complex and multi-dimensional and may have different themes and sub-themes that need to be identified and analyzed to understand their underlying meanings. Subsequently, conclusions were drawn from the findings and their practical implications were discussed.

Furthermore, thematic analysis enables you to identify recurring patterns and themes in the data and organize them into a coherent framework. This can help spot similarities and differences between the EV policies of different states and the federal government and understand the underlying factors that drive their implementation and effectiveness. Also, it can help generate insights and recommendations for policymakers and other stakeholders involved in promoting the adoption of EVs (Castleberry & Nolen, 2018).

3. FINDINGS

Although governments at the federal, state, and local level have introduced several policies to incentivize EV adoption across the United States, just over 5% of all drivers own an EV (Randall, 2022). This section presents findings from the thematic analysis and comparison of EV policies in California and Texas to discover why EV adoption in California is approximately 5 times higher per capita than in Texas (Alternative Fuels Data Center, 2022). Also, the findings should help answer the research questions.

Furthermore, the results of this research were divided into themes and subthemes where EV policies were classified and compared by state. Moreover, findings regarding policies are organized against three levels of analysis: individuals, private entities, and state and local governments, in that order.

Lastly, most findings were extracted from one source, the Alternative Fuels Data Center website. This applies to all findings without an in-text reference.

3.1. EV Laws Themes California and Texas

3.1.1. Policies for individuals

Monetary incentives

Historically, it's been proven (Carrera et al., 2018; Iyer & Kashyap, 2007) that monetary incentives get people to take a desired action. Moreover, it is a common practice for the federal government and U.S. states to pass legislation to incentivize citizens to change their habits, which will be evidenced throughout this section. When it comes to the adoption of electric vehicles, this method also applies.

EV purchase rebates

California residents have an abundance of monetary incentives available to them, but the majority are in the form of rebates. These can either be offered by state or city governments or by companies. For example, the California Air Resources Board (CARB) offers EV purchase rebates and grants that range from $750 to $5,000 to eligible residents. Furthermore, the Bay Area Air Quality Management District offers up to $9500 for qualifying residents who voluntarily retire their vehicles and replace them with an EV. Also, companies like Alameda Municipal Power and MCE offer eligible customers EV purchasing rebates of up to $1,500 and $3,500 respectively.

In Texas, DME offers its customers a $300 purchase rebate that's contingent on them charging their EV during off-peak hours. Also, the Texas Commission on Environmental Quality (TCEQ) offers rebates of up to $5,000 to residents who purchase an EV, among other types of alternative vehicles.

Compared to the more than 15 EV purchase rebates in California, Texas residents have less than 5 such options, according to the Alternative Fuels Data Center.

EV infrastructure home installation rebates

Charging station installation rebates are available for residents in some cities in California and they are mainly offered by companies. For example, Central Coast Community Energy (CCCE) offers up to $10,000 for eligible residents who install an eligible charging station at their home.

EV charging infrastructure rebates in Texas are more widely available for consumers compared to purchasing rebates and they are offered by private entities. Qualified residents can access rebates up to the $1,200 offered by Austin Energy for the purchase and installation of residential EV charging stations.

Energy rebates

Consumers in California also have the chance of receiving discounts in their electricity rate for when charging their EVs. These are offered mostly by energy companies. For example, Azusa Light & Water offers their customers an energy rebate of $0.05 per kilowatt-hour when they charge their EVs during off-peak hours, which is when less customers use electricity. Similarly, Glendale Water and Power offers an incentive of $8 per month to customers who charge their EVs during off-peak times. Moreover, Burbank Water and Power and Sacramento Municipal Utility District (SMUD) offer discounted electricity rates for customers charging their EVs.

Similarly to purchasing rebates, the amount of monetary energy incentives is low for Texas residents, and these are offered by private entities. Specifically, there are less than five such incentives in the state and they are mainly offered by CPS Energy provides EV owners with a $96 fixed electricity rate per year per vehicle. Also, they offer energy $125 bill credits to customers who charge their EVs during off-peak times.

Incentives and benefits for low-income customers

Consumers who live in underprivileged areas and those who earn low-income amounts are frequently taken into account in California's EV policies and mandates. Furthermore, companies also tend to offer higher rebate amounts to low-income consumers.

For example, the Zero Emission Assurance Project (ZAP), which will be discussed in more detail in the environmental mandates theme, must specifically measure the initiative's impact on low-income consumers' decision to buy zero and near zero emission vehicles, which could be EVs. Additionally, the ZEV Market Development Office was created to improve access to zero-emission vehicles (ZEVs) and ZEV infrastructure in low-income communities, among other goals.

Furthermore, private entities like Peninsula Clean Energy offer rebates for purchasing EVs of up to $4,000 for low-income residents. Also, Silicon Valley Power offers rebates above their usual $550 amount for low-income customers. Similarly, companies are incentivized to invest in disadvantaged communities through the California Clean Mobility Options Voucher Pilot Program, which awards eligible projects up to $1,000,000. Mainly, these projects should focus on the development of EV infrastructure and community outreach programs.

Contrary to California, there is no emphasis on creating policies for low-income and disadvantaged communities in Texas.

Policy mandates for individuals

Governments establish rules and mandates that individuals must follow or that are beneficial for them. When it comes to EVs, there are policies that protect consumer rights and thereby must be respected by fellow individuals.

The California civil code establishes that communities and condominiums may not restrict an individual from installing an EV charger or time-of-use-meter (TOU), which is a device that measures the amount of electricity consumed during different times of the day, in their designated parking space. However, the homeowner must pay for all expenses associated with the charging station, including but not limited to installation, maintenance, repair, and replacement. Furthermore, the homeowner must protect the residential development by having a $1 million liability coverage policy and include it as an insured entity. Also, it is prohibited to park a motor vehicle in a space specifically designated for parking and charging EVs unless the vehicle is electric. Lastly, residents who own zero-emission vehicles (ZEVs) must pay a $100 annual road improvement fee after registering vehicle models from 2020 and later.

Regarding policies that are catered towards individuals or made for them to follow, Texas residents have no EV-related mandates to follow currently. This could be a potential blunder since there are no specific policies to protect the rights of EV owners, meaning they are grouped with the rest of vehicle owners. Also, this could lead to potential EV buyers lacking motivation to switch to an electricity-powered vehicle because there are no specific policies like designated parking spots for EV owners which give them the opportunity to charge their vehicle while parked.

3.1.2. Policies for business entities

Monetary Incentives

Companies and private entities play a big role in a state's economic prosperity and have the financial muscle to influence societal change for the better. However, if change will not benefit them greatly, then they may need to be incentivized.

Purchase rebates and grants

When it comes to rebates and grants for the commercial purchase of EV or EV infrastructure, the options are vast and are provided by state and local government entities, along with private companies. For example, the Air Pollution Control Districts in local governments like Santa Barbara County and San Joaquin Valley offer companies grants of up to 35% of the cost to replace heavy-duty vehicles like trucks with ZEVs.

To incentivize companies to reduce emissions from their heavy-duty vehicles, the Texas Commission on Environmental Quality (TCEQ) provides grants for the replacement of diesel vehicles or engines. Although not requiring vehicles to be replaced with ZEVs, it is mandatory that the replacement results in a nitrogen oxide emissions reduction of 25% or more to receive the grant.

EV infrastructure building rebates and grants

Similarly to purchase rebates, private entities enjoy a wealth of options that incentivize EV infrastructure investments; these are offered by government agencies and businesses. For example, the Los Angeles Department of Water and Power offers commercial rebates of between $75,000 and $125,000 for companies that invest in direct-current fast charging stations (DCFC); these are more expensive because they charge vehicles significantly faster.

Although options are not vast to get an EV infrastructure rebate in Texas, Austin Energy does offer between $4,000 and $10,000 in rebates for workplaces that install an EV charging station. Also, multi-unit dwellings qualify for these rebates, given that all residents can make use of the EV charging station.

Corporate mandates and standards

Perhaps the most important aspect when it comes to the development of EV technologies and infrastructure is the implementation of corporate policies that protect consumers and the environment; these mandates should aim to increase EV adoption and ensure private entities take part in the reduction of carbon emissions in an ethical manner.

Although not specific to EVs, vehicle manufacturers are allowed to sell directly to consumers. However, there are limitations. For example, they can do so as long as they are not competing with an independent dealer selling the same vehicle model in that particular area (WisPolitics, 2021).

In stark contrast, companies in Texas are required to sell their vehicles to dealerships owned by a third party, which consumers can buy from (WisPolitics, 2021). Besides this mandate, there are no EV-specific policies or standards that EV manufacturers must follow in the assembly process. Similarly, there are no pricing mandates for businesses offering EV charging services.

Environmental mandates

Due to private entities like car manufacturers being responsible for part of the carbon emissions and greenhouse gasses caused by gas vehicles (Miller & Newby, 2019), it makes sense they are obliged to reduce these harmful pollutants.

To ensure pollution and emissions reduction from heavy-duty trucks and buses owned by private entities, it is mandatory for all such vehicles to replace their diesel engines with models of 2010 or later. This mandate was established by the CARB as part of the Mobile Sources Program (California Air Resources Board, 2019).

Conversely, Texas does not have any specific environmental mandates for companies to abide by.

3.1.3. Policies for government and public entities

Monetary incentives

Monetary incentives are a great way for state, and local city governments to move forward with legislation in a particular area. Also, they can promote positive changes in these governments and the way they function.

When it comes to EVs, there are a vast array of monetary incentives for state and local governments which are also available to public entities like schools and police departments, among others. The goal of these policies is to foster the adoption of EVs at a governmental level. This can be seen in the form of rebates and grants for the purchase of EV fleets and EV charging infrastructure as well as funding programs.

Fleet purchase rebates and grants

There are a couple of fleet purchase rebates and grants available to incentivize public agencies and entities in California to upgrade their fleets with EVs. These rebates are offered by the state. To achieve this, public agencies and entities get EV purchase rebates ranging between $1,000 and $7,000 and the chance to apply to up to 30 rebates. Disadvantaged areas are given priority and higher rebate mounts. Likewise, the San Joaquin Valley Air Pollution Control District offers public agencies and entities grants of up to $20,000 per EV. Also, an agency or entity may receive a maximum of $100,000 in EV grants per year. Also, although not considered a fleet, the CARB offers transport agencies an exemption from state taxes when purchasing a zero-emission transit bus.

Texas has the Governmental Alternative Fuel Fleet Program (GAFF), in which grants are offered to incentivize alternative fuel vehicle purchases, including EVs. It must be noted that only public agencies with fleets of 15 or more vehicles are eligible for the grants, which range between $15,000 and $70,000 depending on vehicle class. Also, the Texas Commission on Environmental Quality (TCEQ), which oversees the GAFF, offers grants to school districts to replace school buses with lower emission alternatives.

EV infrastructure building rebates and grants

Rebates and grants to facilitate building EV charging infrastructure are widely available for public entities and government agencies in California. These are offered by both the state and private companies. For instance, transit agencies have the chance to get EV charging station rebates between $15,000 and $42,000 from Pacific Gas & Electric (PG&E).

Government agencies and public entities in Texas can use 10% of grants received through the GAFF towards the purchase and installation of alternative fuel infrastructure. Otherwise, there are no specific infrastructure-related rebates or grant initiatives at the state or local government level.

Public mandates and standards

State agencies and local governments must follow certain mandates established by a state's lawmakers. These mandates can be either reports, assessments, action plans, developing initiatives, or the enforcement of industry standards, for example. It is key for public agencies and local governments to comply with these mandates to achieve the desired outcomes and to show the fruits of their work. After all, local governments' performance is judged by the state's authorities and following the mandatory policies in practice shows the fulfillment of their responsibilities.

In California, state agencies must deliver close to a dozen EV-related reports and assessments. The overall goal of reports and assessments is to create action plans that result in higher EV adoption and infrastructure availability, as well as increased consumer awareness regarding EVs. For example, the ZEV Promotion plan requires state agencies to collaborate with the private sector to achieve targets like having 250,000 EV public chargers by the year 2025 and a total of 5 million ZEVs in California roads by 2030 while making EV charging accessible and affordable for all drivers, among other goals. Another California's signature EV mandates is the Light-Duty zero-emission vehicle Sales Requirement, which dictates that all sales of new vehicles must either be ZEVs or plug-in hybrid electric vehicles (PHEVs) by 2035.

Also, the California Energy Commission must create, publish, and maintain a website with EV infrastructure information for consumers to determine if their homes are suited for EV charging infrastructure.

In Texas, state agencies must submit a couple of reports and plans with the goal of developing EV infrastructure and having a clear picture of registered alternative fuel vehicles (AFVs). For instance, the Texas Department of Transportation (TxDOT) is required to send a report to the U.S. Department of Transportation (DOT) where they outline their plan to allocate National Electric Vehicle Infrastructure program federal funds. Furthermore, the Texas Legislature must receive an annual report by the Texas Department of Motor Vehicles (Department) where it describes the amount of AFVs in the state and their type (EVs, HEVs).

Environmental mandates

The California Department of General Services (DGS) is tasked with creating and maintaining emissions standards for vehicles purchased by state or local governments. Moreover, 50% of light-duty vehicles purchased by the mentioned authorities must be ZEVs by the year 2024 and the DGS must work with other agencies to develop initiatives and projects resulting in increased EV adoption by state employees. Lastly, the California Air Resources Board (CARB) must ensure transportation network companies (TNCs) implement ZEVs by 2023 and work towards ZEVs making up 90% of the miles driven by TNCs. To achieve this, the CARB must create and enforce new greenhouse emissions reduction requirements for TNCs.

To qualify for the Texas Clean Fleet Program, the Texas Commission on Environmental Quality (TCEQ) requires eligible entities to purchase AFVs that reduce emissions harmful to the environment by 25% or more. Similarly, the TCEQ must establish the Emissions Reduction Incentive Grants (ERIG) Program, which increases air quality by offering grants to AFV and AFV infrastructure projects that reduce emissions by at least 25%. Moreover, it focuses on the electrification of heavy-duty vehicles, which tend to generate more emissions. Furthermore, the Seaport and Rail Yard Areas Emissions Reduction Program (Program) provides grants for the purchase of heavy-duty and cargo vehicles, which should be EVs and reduce emissions by 25% or more as well.

4. DISCUSSION

In this section, we discuss eight salient findings from this study and discuss them against literature to help us address our research questions: "What are the specific EV monetary incentives and grants offered by local governments and businesses in California and Texas, and how do they differ?" and "What initiatives have been implemented by state and local governments to increase EV adoption among disadvantaged communities in California and Texas?".

1. The adoption of EVs or any new technology can significantly slow down without the inclusion of low-income consumers (Foster & Heeks, 2013). Furthermore, the study links this finding to the **relative advantage** construct because EV ownership is cheaper long-term than gas-powered vehicles (Dumortier et al., 2015), making it a cost-effective alternative for low-income residents.

This could mean that the lack of policies in Texas targeting low-income residents could cause EV adoption to stagnate.

2. As proposed in their study, Xia et al. (2022) states should focus on making consumers aware of the positives of EV adoption and educate them to achieve the diffusion of EVs.

Consumer awareness can be linked to the **compatibility construct**, because knowing about EVs can make people realize that EVs are compatible with their needs and/or beliefs (saving the environment). Similarly, it can be linked to the **usefulness construct** because knowledge of EV capabilities like range or available infrastructure can enlighten the consumer on the value of EVs and remove concerns of EV ownership being challenging **(complexity construct)**.

3. The findings are concurrent with previous literature suggesting incentives have a positive correlation with EV adoption (Langbroek et al., 2016) and that price-related incentives increase EV adoption due to EV ownership costs being significantly lowered (Clinton & Steinberg, 2019). This could also be a factor for California having higher EV adoption since their EV purchase grant and rebate amounts tend to be significantly higher than those in Texas. These monetary incentives fall into the **relative advantage construct** because they offer benefits to the consumer to incentivize EV adoption.

4. The findings suggest that both states prioritize EV charging infrastructure policies, which is in line with previous research suggesting the availability of charging infrastructure significantly affects EV adoption (Narassimhan & Johnson, 2018). These measures could be linked to the **complexity** and **ease of use constructs** because they remove one of the challenges of EV ownership, which is available charging infrastructure, thus making it easier for consumers to charge their EVs at multiple public locations.

5. The data suggests that California makes it easier for manufacturers to sell directly to customers, which could affect EV adoption.

On the other hand, companies in Texas are required to sell their vehicles to dealerships owned by a third party, which consumers can buy from (Texas Department of Motor Vehicles, 2023). Moreover, whether consumers have access to Tesla vehicles, for example, in their state can affect their opportunities of trying an EV; this falls into the **trialability construct**. However, there is not enough current literature to support this. In fact, the Renewable and Sustainable Energy Reviews journal (Mukherjee & Ryan, 2020) found that living within 10 kilometers of a car dealership is a negative predictor of EV adoption. Nonetheless, the study focuses only in central urban areas of Ireland, so this could be an area for further research.

6. Since there are a variety of private entities offering EV charging services, it could be a threat to consumers if they could manipulate charging prices at will and make EVs more expensive to own than non-EVs. This could result in EV adoption slowing down and even cause EVs to lose their main advantages compared to gasoline-powered vehicles, cheaper refueling rates.

Consequently, the California Air Resources Board (CARB) states private entities may not use a subscription or membership-based model for EV charging services; this goes in line with the consumer trend of avoiding subscription-based models to save costs (Portell & Thomas, 2022), falling under the **compatibility construct**.

In contrast, the lack of pricing mandates for EV charging providers in Texas could mean EV owners in Texas are at the mercy of private entities drastically rising refueling prices and changing the pricing structure in the future.

7. Lastly, the author was surprised by the stark contrast in EV-related government mandates in California compared to Texas.

California banned manufacturers from selling new non-EVs from 2035 onwards and has made it mandatory for public agencies and commercial facilities alike to install EV chargers in parking spots, depending on the parking lot size. This could increase EV adoption since more employees would have access to EV charging infrastructure and seeing it daily would increase familiarity, which would fall into the **observability construct**; this construct is supported by a study from the journal of Energy Policy (Silvia & Krause, 2016), which found that EV policies which increase familiarity are most effective in increasing adoption. Similarly, the Research in Transportation Economics journal (Wu et al., 2020) found with a 95% confidence interval that familiarity with EVs is correlated to higher willingness to use and higher intention to purchase an EV.

8. In California there are a variety of mandates, standards, and requirements which EV manufacturers and government agencies must strictly comply with. For example, transportation network companies are required to start adopting zero-emission vehicles (ZEVs) from 2023 and by the year 2030, they must represent 90% of all miles driven, which would fall into the **mandatory construct**.

According to a 2022 survey by the U.S. Energy Information Administration (EIA), Texas was the U.S. state with the highest transportation sector carbon emissions, with California coming in second. So, it is odd that Texas does not have any mandatory EV production targets or emissions quotas for manufacturers to abide by (Statista, 2022). Also, consumers who are aware of the environmental benefits of EV ownership are more likely to purchase an EV (Irfan & Ahmad, 2021), so a lack of emphasis on environmental awareness programs could be a policy blunder.

Based on the discussion of the findings, we make the following practical suggestions:

- Provide more financial incentives for EV buyers in Texas
- Implement policies targeting EV adoption in disadvantaged communities in Texas
- Develop programs to increase awareness and education about EVs.
- Implement regulations and incentives for automakers to produce more EVs.

- Promote the use of renewable energy sources for EV charging.
- Differentiate between which policies should be optional and which should be mandates to ensure EV adoption targets are met.

5. CONCLUSION

This chapter concludes this research paper by offering the reader a summary of the key findings and their applicability, and how they relate to the research aims and questions. Also, the author recaps the study's contribution as well as its limitations, and proposes recommendations for future researchers.

This research paper aims to find out why EV adoption in California is approximately 5 times higher per capita than in Texas by comparing the states' EV policies, assess which ones could have a direct impact in the diffusion of EVs and how they differ. The author used a qualitative research approach to collect secondary data from federal, state, and local government websites and databases. Then, using thematic analysis, EV policies from California and Texas were classified into themes according to whether the policy was geared towards individuals, private entities, and state and local governmental agencies.

This paper is based on the following research questions:

1. What are the specific EV monetary incentives and grants offered by local governments and businesses in California and Texas, and how do they differ?
2. What initiatives have been implemented by state and local governments to increase EV adoption among disadvantaged communities in California and Texas?

The findings suggest that California's per capita EV adoption rate is 5 times higher than Texas due to the following key EV policy differences:

- California consumers have as much as three times more EV purchase grants and rebates than their Texas counterparts (15 to 5, respectively) with monetary amounts being significantly higher for the former, which could be an enabler for EV adoption.

- California incentivizes businesses and local governments to develop EV infrastructure projects in low-income and disadvantaged communities, which similarly to Texas, make up more than 10% of the state's population. However, the latter lacks policies targeting low-income residents.

- Lastly, California requires state agencies and local governments to develop consumer awareness initiatives to educate the public on EVs and ease common concerns like the perception that EVs do not travel far (range anxiety) or that there is no charging infrastructure nearby. While Texas incentivizes the development of EV charging infrastructure across the state, it has few, if any, policies aimed at increasing consumer awareness of EVs, which previous research suggests is correlated with an increase in EV adoption.

These findings coincide with the current literature and are relevant for policymakers in California and Texas because they suggest which differences in EV policy and strategy affect the diffusion of EVs. However, other states could also benefit from the contributions of this study if they are applicable to their current economic, social, and market conditions.

As mentioned in the introduction section of this chapter, the study aims to find out how the differences in EV policies in California and Texas affect adoption. The results show that consumers and businesses have significantly more rebates and grant options incentivizing either the purchase of an EV or charging infrastructure, with higher monetary amounts in California.

This study contributes to the current literature by addressing a gap in research focusing on EV laws in Texas and California because there are few, if any, studies comparing the states' policies and how they affect the diffusion of EVs. Furthermore, it builds on previous studies which used the diffusion of innovation theory (DOI) and the technology acceptance model (TAM) as theoretical frameworks to analyze EV adoption. However, none of them had done so to compare EV policies between U.S. states, and none focused on California and Texas, which represent the states with the largest economies in the country. Moreover, the findings contribute to the literature by comparing and thematically analyzing EV policies of California and Texas and how they impact the diffusion of EVs in these states.

Also, the study proposes a new construct to the DOI, **'mandatory'** to link mandates, requirements, reports, and standards which aim to increase EV adoption by enforcing a desired action. For example, the fact that in California it is mandatory to sell EVs from 2035 and for public agencies to install EV charging infrastructure, among other mandates, has led the author to relate this finding to the new **mandatory construct.**

On the other hand, Texas has few if any such policies, which could be a policy blunder resulting in slower EV adoption.

When it comes to the real-world implications of these results, policymakers, manufacturers/distributors, and consumers should take the key differences into account when crafting EV-related policies and when deliberating whether to implement them. Specifically, they should differentiate between which policies should be optional and which should be mandates to ensure EV adoption targets are met.

This research paper has limitations that were not accounted for. For example, the study does not consider the date EV policies were implemented at the state or the Federal Government level. Also, it mainly focuses on California and Texas, which have the largest economies in the U.S. and already are among the states with highest EV and available EV infrastructure. This means that the findings may not be applicable by states with significantly less resources and economic development, among other factors.

For future research, it would add more context and validity to the study if the researchers focused on the date in which certain policies were implemented and if this correlates with an increase in registered EVs from that date onwards, for example. Also, future research could expand the results by comparing EV policies of states with significantly less EV adoption and economic resources.

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APPENDICES:

Appendix 1. Full EV policies document

Compilation of California EV polices extracted from Alternative Fuels Data Center document created by author.

Compilation of Texas EV polices extracted from Alternative Fuels Data Center document created by author.

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