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All-electric vehicles (EVs), battery-powered EVs (BEVs), and plug-in hybrid EVs (PHEVS) are gaining market share and increasing in popularity with the buying public because the battery range (longer) and cost (lower) have reached sweet spots, the charging infrastructure is more robust, and concern with global climate change is high. In 2013, only 100,000 EVs were sold in the United States, but by 2022, approximately 800,000 have been purchased. A similar growth is seen in EV supply equipment (EVSE), i.e., EV charging stations, with 19,742 documented EV charging station locations in the United States in 2013 to 50,054 documented EV charging station locations, with approximately 130,000 ports, by the end of 2022.

As impressive as this growth is, the eightfold increase in EV sales is inconsistent across individual states. While geography and the states' differing physical and demographic conditions play a role, state and federal EV and EVSE policies play an outsized role in the differences among the states.

While the federal government can enact nationwide policies to increase EV adoption in the United States, it is also up to each state to incentivize EV adoption through their own policies and initiatives in their legislation. As of August 2021, 44 states had some form of charging infrastructure incentives, and 32 states had some form of EV incentives. (The nomenclature used in each state's legislation changes in reference to EVs with the most common being *EVs/BEVs* referring to EVs powered by an electric battery and *HEVs* referring to vehicles that can utilize more than one form of onboard energy. However, some states, such as Nebraska, refer to EVs and HEVs as *alternative fuel vehicles*, and California refers to EVs as *zero-emission vehicles*. For simplicity, EVs will be used to refer to any of these vehicle classifications.)

This article intends to shed light on the federal and state policies that most influence uniform and nationwide EV adoption—or the lack thereof. The first section, "LRTPs," is about long-range transportation plans (LRTPs), prepared by each state's transportation department, that

include EV promotion in future planning. The second section, "Motor Fuel Tax and Vehicle Registration Fees," is about EV registration fees, a legislative action to mitigate motor fuel tax reduction from increased EV usage. The third section, "Federal, State, and Utility Incentives," is about federal, state, and utility incentives to support the adoption and deployment of EVs and EVSE.

LRTPs

Every state has an LRTP prepared by the state's respective transportation department. LRTPs are used to study multiple topics, such as mitigating emissions, roadway safety, and innovative technologies. Furthermore, an LRTP may evaluate public health considerations, address vehicle emission problems, and encourage improved automobile technology. Each state's LRTP is unique to the state, is published every 5–10 years, and covers planning for a 20–30- year period. Due to recent advances in EV technology, usage, and availability, many states have updated their LRTPs to address EVs. The recently published plans are more likely to be well-equipped plans to facilitate EV infrastructure and advance the EV market in the respective state. The importance and forward-facing impact of LRTPs cannot be understated. LRTPs play a huge role in a state's readiness to incorporate EVs into common usage.

States differ in the information their LRTPs contain about EVs. Two main topics emerge in most states' LRTPs regarding EVs: discussion of the motor fuel tax and EVs and discussion of EVSE locations. Of all 50 states, only five states' plans do not mention these two subjects. **Figure 1** depicts which states include a discussion of the motor fuel tax and EVs and which states include a discussion of associated EV refueling infrastructure or locations for EV charging stations.

The motor fuel tax is critical funding for a state government's budget to build and maintain roads and bridges within a state. Any purchase of gasoline-based fuel contributes to this fund. Because all BEVs use electricity as fuel, they do not contribute to this tax pool. Additionally, PHEVs contribute very little to this fund. As more EVs replace conventional internal combustion vehicles, less motor fuel tax will be collected at the gas pumps to maintain roads and bridges. Future increases in EV driving, as well as higher fuel efficiency standards in gas-powered vehicles,

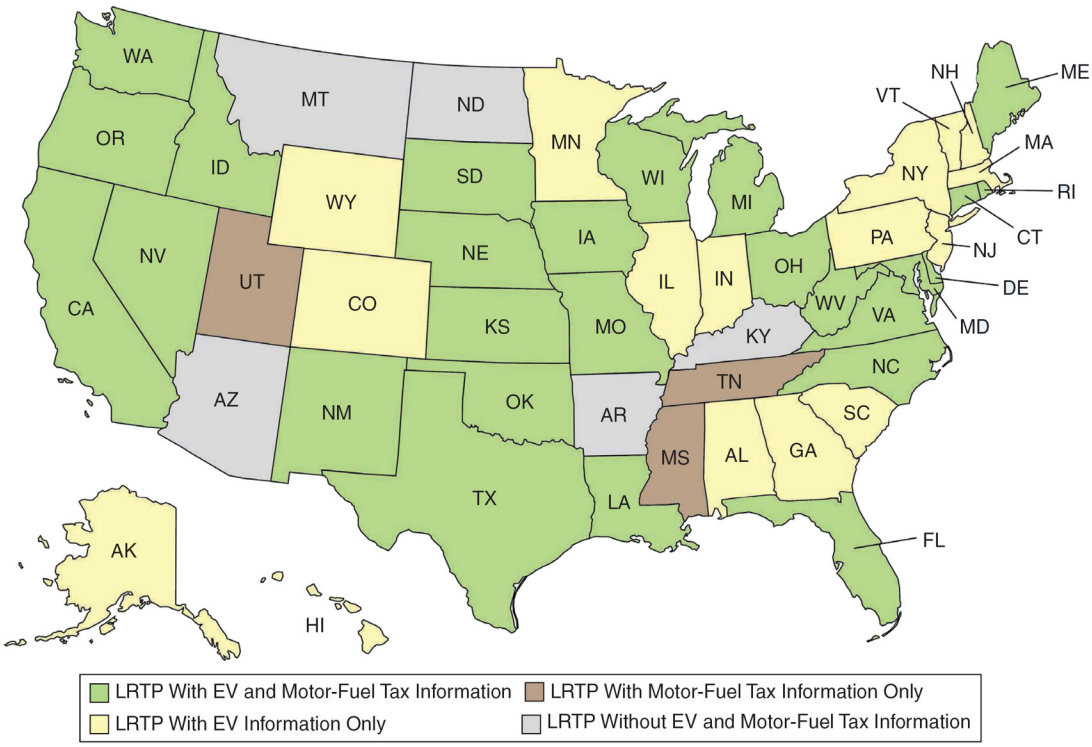

Figure 1. A summary for states mentioning EVs, motor fuel tax information, or no information. (Note: Figure based on data from each respective state LRTP.)

will further decrease this fund. Expected drops in the funds from the motor fuel tax are the reason 29 states address how to fund roads in their LRTPs. These 29 states fall into two categories depending on their discussion of the motor fuel tax fund reduction. Either they include a plan with additional actions to combat the reduction, or they mention only that the decrease may be an issue in the future.

EVs and the associated charging (refueling) infrastructure are important elements of discussion for state LRTPs if they wish to take action to increase EV uptake on roads. To provide guidance toward this increase in use, 42 states mention EVs and associated charging infrastructure within their LRTPs. However, the discussion of EVs and associated infrastructure varies in depth and scope. There are four mutually inclusive broad categories in which EVs are mentioned in state LRTPs.

- general mention of EVs as a technology that needs to be addressed in the future

- a plan to develop EV charging infrastructure within the state to promote EV development
- a plan to purchase EVs as state vehicles to promote EVs in the state
- a plan to provide incentives to promote EV sales within the state.

Each state has a different level of discussion regarding these four categories, and more established EV plans include several of the categories in their writing. For example, Iowa, Oklahoma, Maryland, and Illinois are among the states where the LRTP has incentives for the state's residents to purchase EVs, along with plans for EV charging infrastructure development in the state. **Figure 2** shows a Venn diagram providing details of the LRTPs of the 50 states and information on the four categories of EVs and associated charging infrastructure discussion.

It is pertinent to include that while LRTPs are very helpful for road mapping the plans of states to engage in actions relating to EVs and infrastructure and are influential in their efforts, they are not bound to the actions listed in their respective LRTPs. Regarding the motor fuel tax and EV-associated charging infrastructure, many states have taken proactive steps to address these issues regardless of whether the state LRTP addressed them.

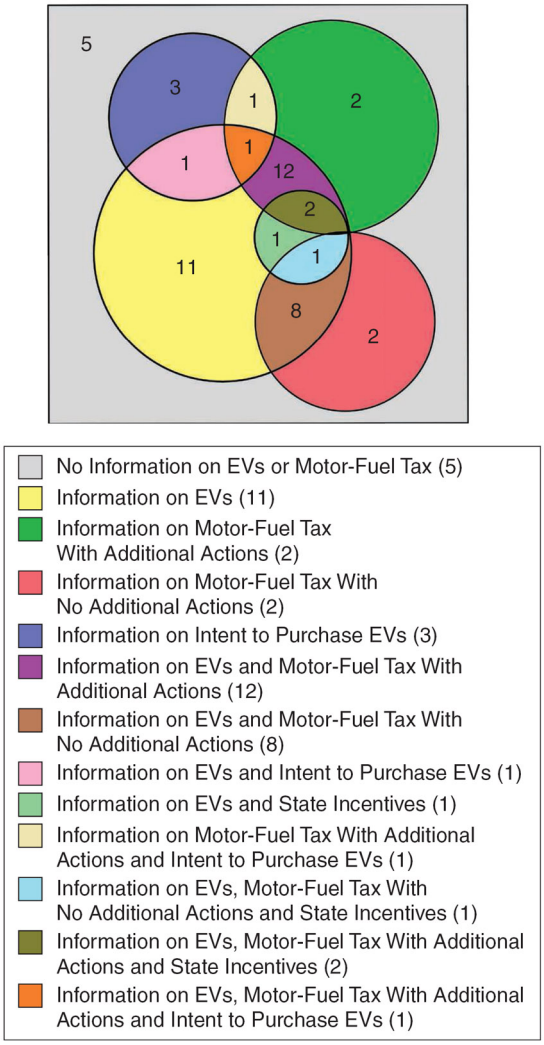

Figure 2. A Venn diagram of EV and motor fuel tax information in the LRTPs of all 50 states. (Note: Figure based on data from each respective state LRTP.)

Motor Fuel Tax and Vehicle Registration Fees

Efficient road maintenance and transportation upkeep require funding from state governments in the United States. Each state has different laws that allocate the funding for this budget item. Two common sources of revenue common to all states are

- motor fuel taxes
- vehicle registration fees.

States set the rates of these fees so that drivers contribute to the ongoing expense of the roads and bridges they use. However, the availability and market penetration of EVs for transportation create opportunities and challenges for each state. Because EVs do not burn traditional motor fuels for propulsion, the EV owner does not contribute directly in this manner to funding roads and bridge funds, so 31 states propose to add EV registration fees. **Figure 3** shows the states that have legislation regarding additional registration fees for EVs. Although the remaining

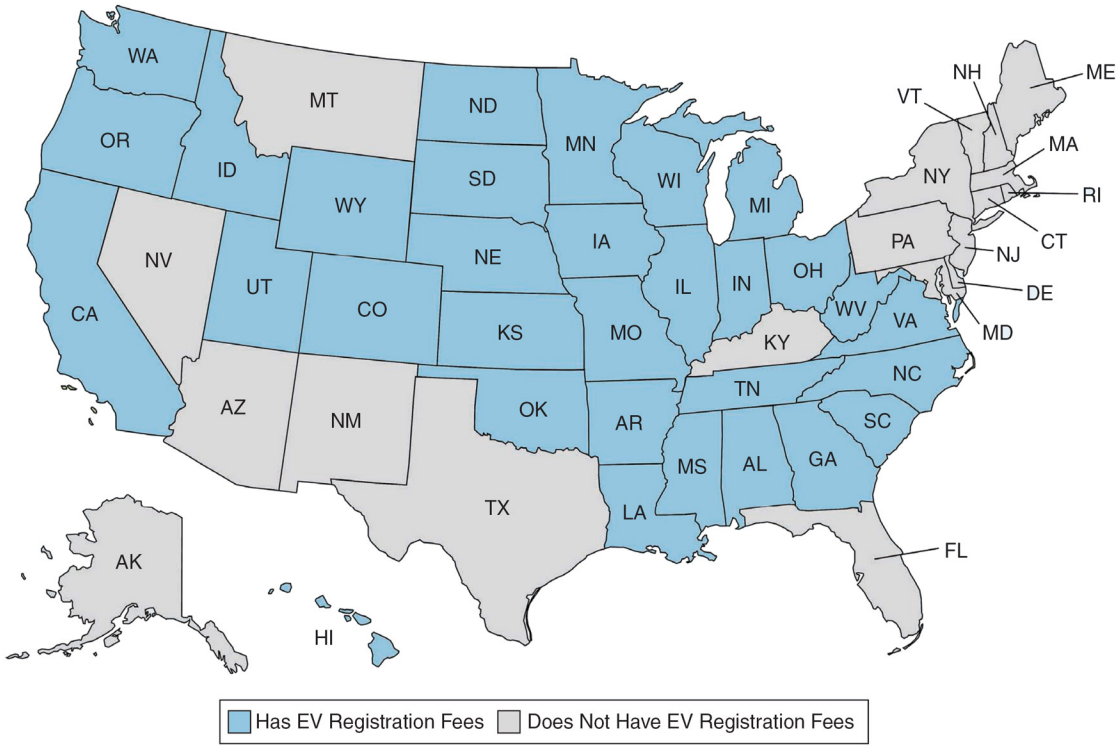

Figure 3. States with legislation regarding additional registration fees for EVs and PHEVs. (Note: Figure based on data from National Conference of State Legislatures.)

states do not have EV registration fees, plans for mitigating losses to road funding are sprouting up in LRTPs. They can be seen in the form of road user charges, mileage fees, or EV registration fees for the aforementioned 31 states.

For the states that have special registration fees for EVs, distinctions are made between how the fee is applied to EVs and PHEVs, respectively. It is seen that the owners of EVs pay higher registration fees than the owners of PHEVs in many states. This can be attributed to the fact that EV owners do not purchase motor fuel in any capacity for their vehicles and thus do not pay any motor fuel tax, while owners of PHEVs purchase a small amount of motor fuel for their EVs and do contribute in a small portion to road funding. Because of this, certain states differentiate between EVs and PHEVs for registration fees.

Of the 31 states with registration fees, 18 have separate PHEV fee amounts, with the rest having only EV funds or considering EVs and PHEVs in the same category. A breakdown of the fees for each state is presented in **Figure 4**.

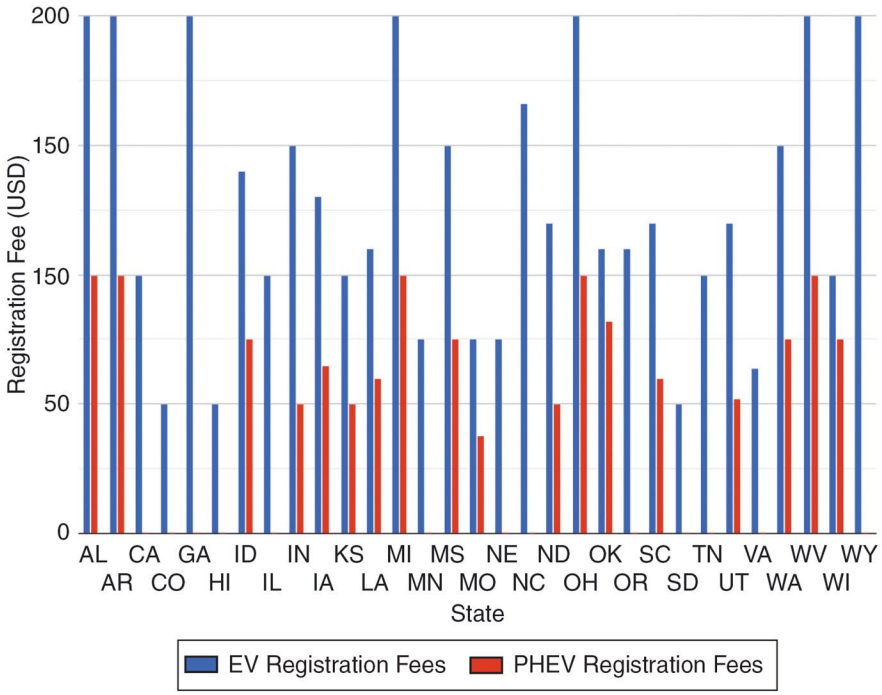

Figure 4. Registration fees for EVs and PHEVs in each of the 31 states. USD: U.S. dollars. (Note: Figure based on data from National Conference of State Legislatures.)

BEV Registration Fees

Thirty-one states have legislation regarding EV registration fees for EVs in general. The lowest EV registration fee is US$50 in Colorado, Hawaii, and South Dakota, and the highest fee is US$200 in seven states. The mean registration fee value is US$126, and the median is US$120. **Figure 5** shows each state along with its EV registration fee.

PHEV Registration Fees

While 31 states have legislation regarding EV fees, only 18 include PHEV registration fees. The lowest PHEV registration fee is US$38 in Missouri, and the highest fee is US$100 in five states. The mean fee value is US$72, and the median is US$75. **Figure 6** shows each state along with its PHEV registration fee.

When considering the registration fees for EVs and PHEVs, three factors emerge. The first is the difference in the number of fees for each

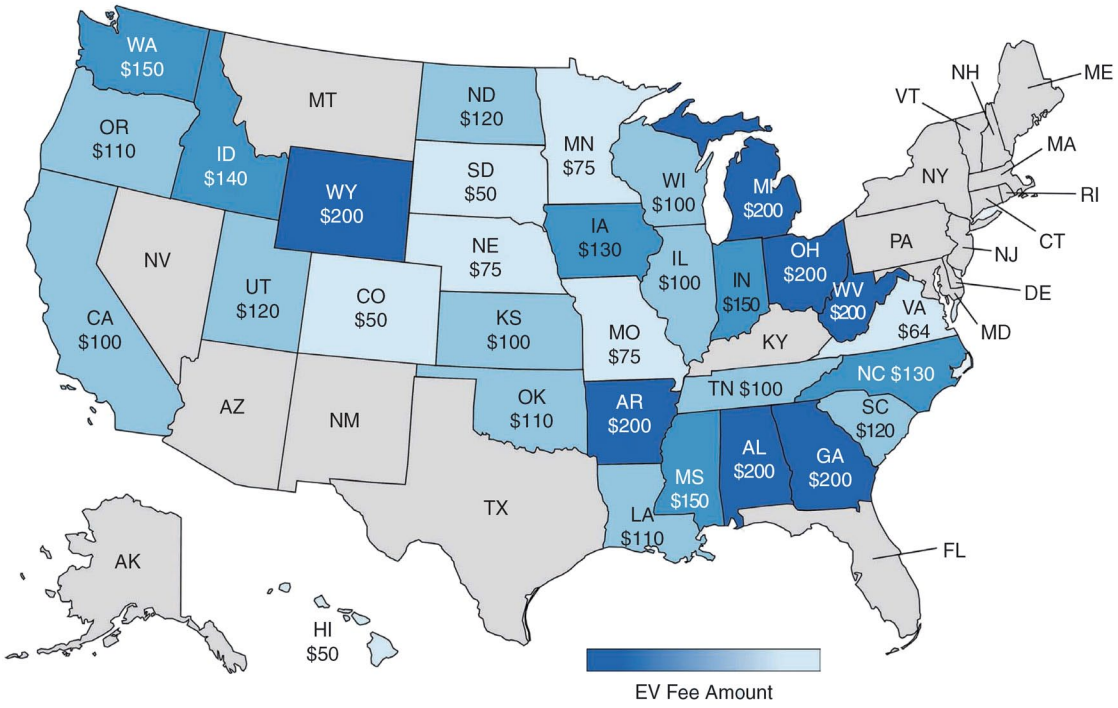

Figure 5. Registration fees for EVs per state. (Note: Figure based on data from National Conference of State Legislatures.)

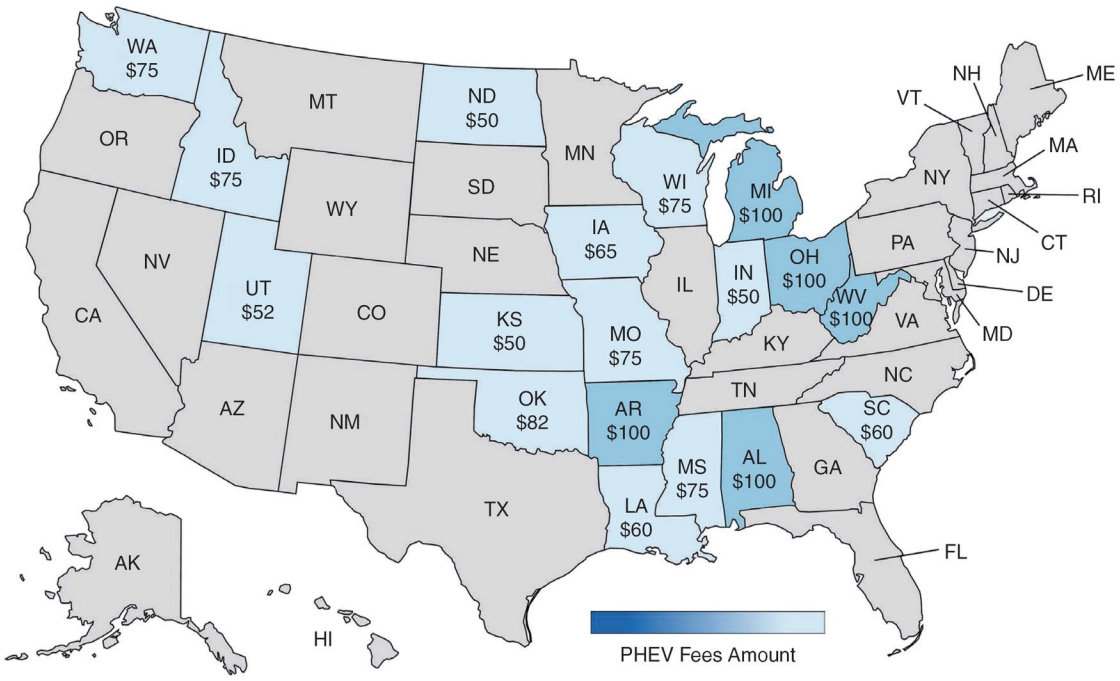

Figure 6. Registration fees for PHEVs per state. (Note: Figure based on data from National Conference of State Legislatures.)

vehicle type, the second is the implied miles driven, and the third is the allocation of the collected fees. With respect to the number of registration fees, EV owners pay higher registration fees in some states. This can be attributed to the fact that EV owners do not purchase motor fuel and pay no motor fuel tax, while owners of PHEVs do purchase motor fuel and do pay a small amount of motor fuel tax. The states that categorize EVs and PHEVs as one vehicle type have a single registration fee for both types. With respect to the implied miles driven, conventional vehicle drivers pay for the gasoline tax fees as they purchase their fuel, whereas EV drivers pay upfront for the miles they will drive.

Furthermore, a preset number of miles are implied in those fees for EV drivers. In 2022, the average gasoline tax in the United States is estimated at 28 cents/gallon. When considering the EV mean registration fee value at US$126, the EV owner pays for approximately 11,430 mi to be driven within a one-year period. For a specific state example, Nebraskans pay approximately 25 cents/gallon in gasoline tax, with a US$75 registration fee for an EV; this then translates to an equivalent of 7,600 mi to be driven.

With respect to the allocation of the collected fees, states vary in how they allocate registration fees collected from EVs. Most states treat the collected fees the same as the traditional registration fees and motor fuel tax, where they are allocated to highway funds, road infrastructure and maintenance, and other public infrastructure funds. This way, they are treated as replacements for fees like the motor fuel tax. However, some states, such as Colorado, Alabama, and Washington, allocate a portion or percentage of the revenue to EV infrastructure specifically, in addition to the rest of the portion allocated to general road infrastructure. In Colorado, 60% of the funds are deposited into the Highway Users Tax Fund, and 40% of the funds are deposited into the Electric Vehicle Grant Fund, which administers grants for installing charging stations and their operating costs. In Alabama, US$50 from each EV registration and US$25 from each PHEV registration are deposited into the Rebuild Alabama Fund, which helps to fund EV charging infrastructure through the Electric Transportation Infrastructure Grant Program. In Washington, the US$75 PHEV fee goes toward the purchase and installation of EV charging stations.

Federal, State, and Utility Incentives

The widespread adoption of EVs within the United States will not be possible without actions from the federal government, state governments, local governments, and private and public entities. To increase the EV adoption rate in the United States, each of these entities employs actions in the form of monetary and nonmonetary incentives to encourage the adoption of EVs through several means. The three federal legislative actions investigated in this article are the Volkswagen Mitigation Fund actions, the Bipartisan Infrastructure Investment and Jobs Act, and the Inflation Reduction Act (IRA) of 2022. Additionally, actions employed at the state level are discussed, with Nebraska used to showcase the available incentives at length.

Volkswagen Mitigation Fund

Between 2009 and 2016, Volkswagen sold approximately 590,000 diesel motor vehicles in the United States that violated the Clean Air Act.

As a result, the U.S. Environmental Protection Agency resolved a civil enforcement case against Volkswagen and its affiliated companies with three partial settlements. It required Volkswagen to spend up to US$14.7 billion in mitigation, with US$2.885 billion invested toward environmental damage distributed to each of the states. The distribution of the Volkswagen Mitigation Funds was based on factors such as population size and environmental impact due to the nitrogen oxide (NOx) emissions from Volkswagen. With this funding, every state was presented 10 options for mitigation actions to reduce NOx emissions, one of which was the investment toward EVSE infrastructure.

Each state was required to draft a Beneficiary Mitigation Plan (BMP) to determine which mitigation options they were pursuing and what percentages of the funds will go toward each option. Usage of mitigation funds toward EVSE infrastructure in each state is limited to 15% or less of the mitigation funds. Of all 50 states, 41 states utilize the full 15% of the funds toward EV infrastructure, seven states utilize some percentage of the funds but not the maximum 15%, and two states do not utilize any of the mitigation funds toward EVSE infrastructure. As these plans were drafted back in 2017 with the intent of action over a period of several years, many of their actions are still active as of the end of 2021 as their period had not ended yet. A map displaying the amount of funding toward EVSE equipment per state is in **Figure 7**, and a map displaying the percentage of funding used toward EVSE equipment is in **Figure 8**.

Bipartisan Infrastructure Law

The Infrastructure Investment and Jobs Act, also known as the *Bipartisan Infrastructure Law* (*BIL*), is a US$1.2 trillion federal investment into the infrastructure of the United States passed in November 2021. Over the next decade, the investment will improve the clean water infrastructure, broadband infrastructure, road and bridge infrastructure, public transit infrastructure, port and waterway infrastructure, airport infrastructure, railway infrastructure, power grid infrastructure, cyberattack infrastructure, natural disaster infrastructure, and EV infrastructure. While the bulk of funding from the BIL is toward the general utility infrastructure of roads, power grids, water supply, and other essential services, the legislation still provides US$7.5 billion toward a national network of EV chargers in the United States. The milestone that the legislation is

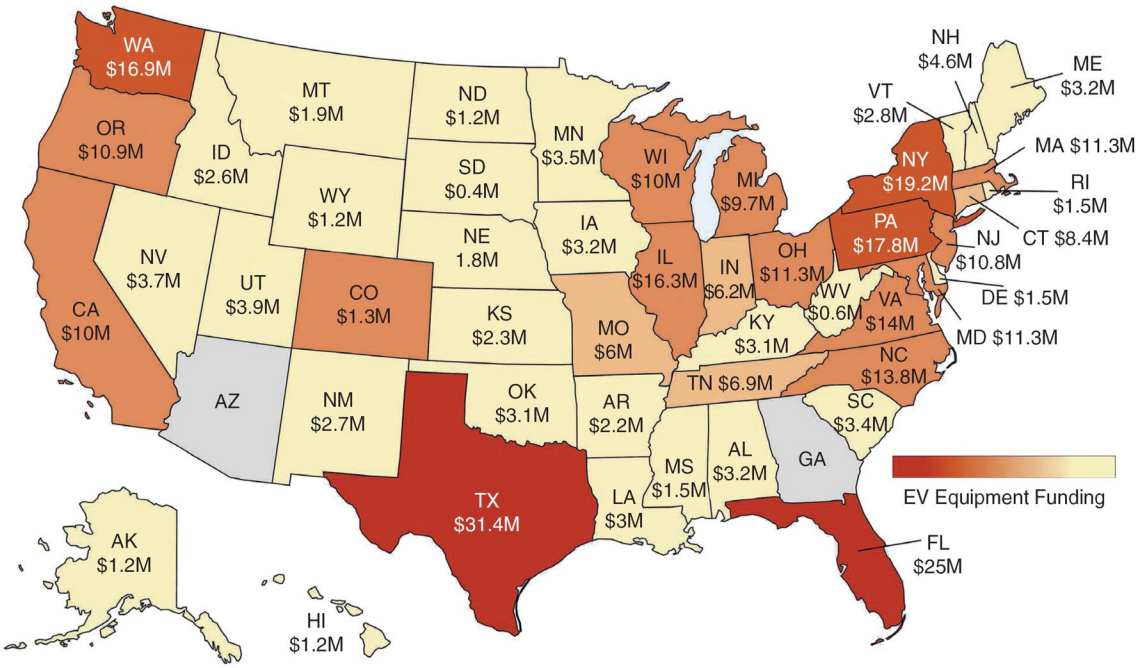

Figure 7. The amount of funding allocated to each state for EVSE equipment from the VW settlement. (Note: Figure based on data from each respective state BMP.)

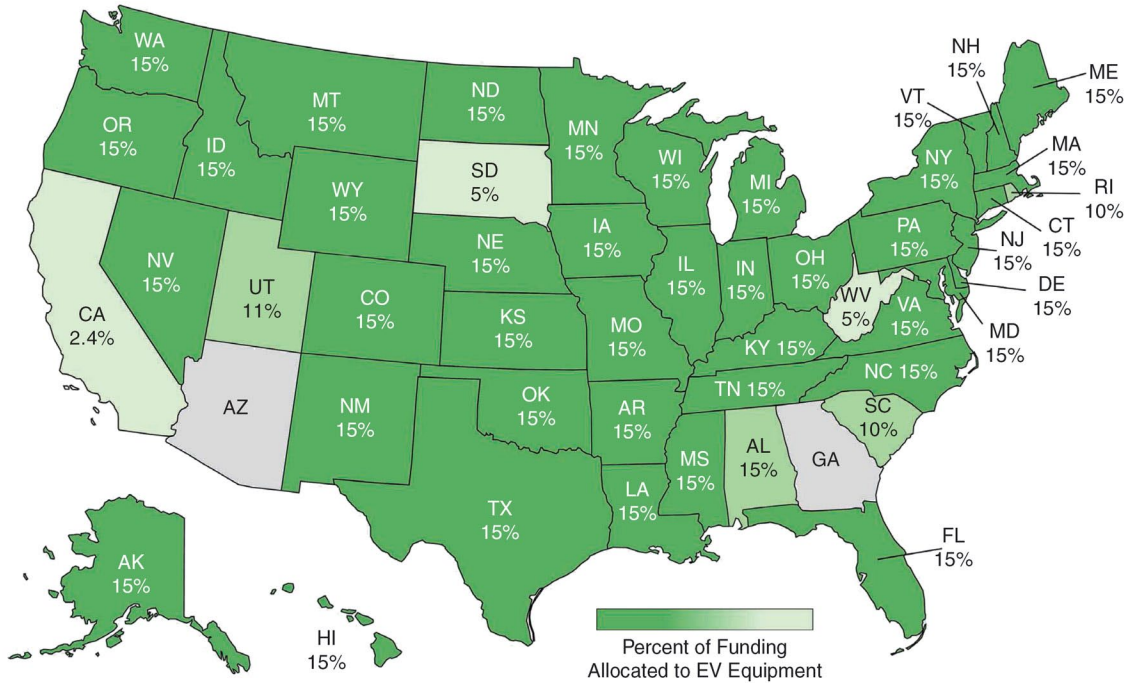

Figure 8. The percentage of funding allocated to each state used toward EVSE equipment from the VW settlement. (Note: Figure based on data from each respective state BMP.)

intended to reach is 500,000 new EV chargers to accelerate EV adoption within the United States and be able to sustain the increased amount of EVs on the road.

EV infrastructure funding is not evenly distributed to each of the 50 states. The amounts vary depending on several factors, such as population size, urban development, the current condition of the EV infrastructure, and the current condition of other infrastructure in each state. Given the parameters, Texas will receive the most amount of funding at US$408 million for EV infrastructure, and New Hampshire will receive the least, US$17 million, for EV infrastructure. A map displaying the EV infrastructure funding for each state is provided in **Figure 9.**

IRA of 2022

In August 2022, Congress and the White House passed the IRA, a multifaceted law to stimulate and grow the economy. This is through reforming the tax code for corporations, revitalizing manufacturing in

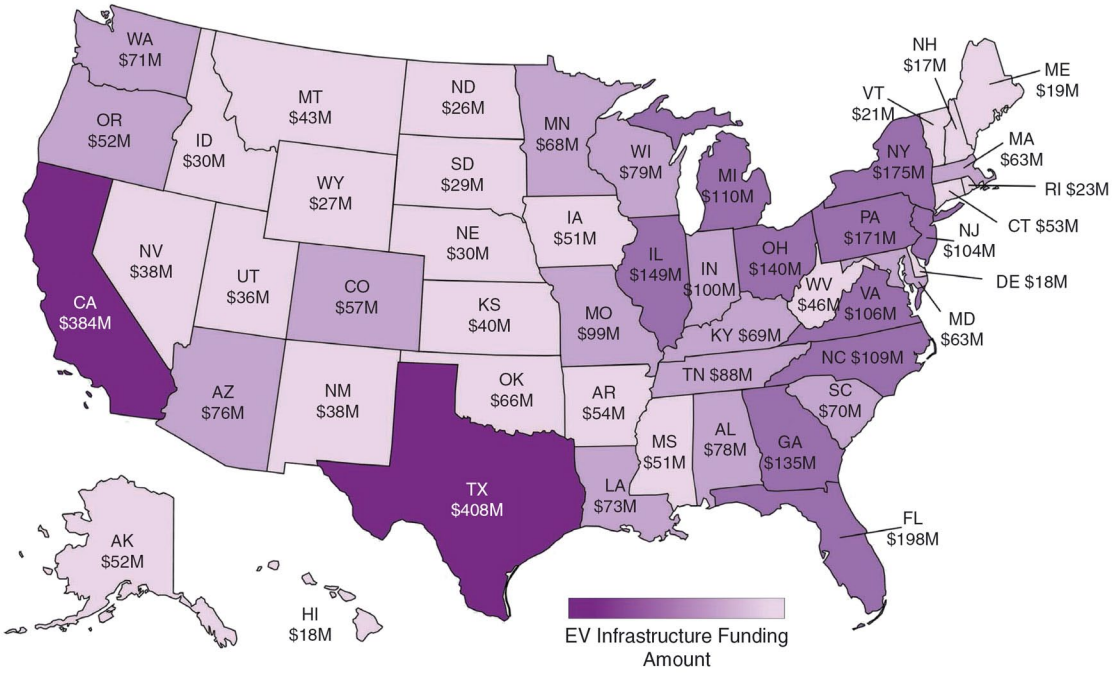

Figure 9. The amount of funding allocated to each state for EV infrastructure from BIL. (Note: Figure based on data from the White House.)

the United States, lowering health-care costs, and creating clean energy jobs. For the purpose of this article, clean energy jobs will be further investigated.

To create union jobs, the IRA seeks to create jobs within the clean energy sector that reduce harmful emissions. Part of this initiative involves tax credits for energy-efficient buildings and EV charging infrastructure. Previously, a federal tax credit was available for EV users called the *Qualified Plug-In Electric Drive Motor Vehicle Credit*; however, this law changed the qualifications and application of this tax credit and renamed it the *Clean Vehicle Credit*. This new law provides up to US$7,500 in tax credits for new EVs and US$4,000 for used EVs depending on the purchase date of the EV, set into three brackets. The qualifications to receive the credit and the application change among the three brackets: before 17 August 2022, between 17 August and 31 December 2022, and after 31 December 2022.

For EVs in the bracket before 17 August 2022, they must meet the specific criteria of a battery with at least 4 kWh of capacity, a gross weight rating of up to 14,000 lb, and specified emission standards. If these are met, the minimum credit amount available is US$2,500, and it scales up to US$7,500 based on the gross vehicle weight rating.

For EVs in the bracket between 17 August and 31 December 2022, the qualifications and application of the credit are the same as the previous bracket but are limited only to EVs with final assembly in North America. Verification of this is checked through the U.S. Department of Transportation's Vehicle Identification Number. If all the conditions are met, the minimum credit amount available is US$2,500, and it scales up to US$7,500 based on the gross vehicle weight rating.

For EVs in the bracket after 31 December 2022, several changes to the requirements and eligibility of the tax credit take place. The scope of eligible vehicles expands to include fuel cell EVs along with EVs, and the battery must have at least 7 kWh of capacity, along with new requirements regarding the manufacturing and production of the vehicles. The US$7,500 tax credit is split into two equal tax credits, each awarded based on different requirements. A US$3,750 tax credit is available if the vehicle manufacturing meets minimum requirements for critical mineral extraction, processing, and recycling. To be eligible, the percentage of the value of the battery's critical minerals extracted or processed in the United States or trade partner must meet 40% in 2023, increasing in 10% increments each year up to 80% in 2027 and later.

The second US$3,750 tax credit is available if the vehicle manufacturing meets the requirements for battery component manufacturing and assembly. To be eligible, the percentage of battery components manufactured or assembled in North America must meet 50% in 2023, increasing in 10% increments each year up to 100% in 2029 and later. In addition, restrictions are placed on the vehicle price and the user's modified adjusted gross income (MAGI). Vans, SUVs, and pickup trucks must not have a manufacturer's suggested retail price (MSRP) above US$80,000, and other vehicles must not have an MSRP above US$55,000. Individuals must have an MAGI below US$300,000 for joint filers, US$225,000 for head-of-household filers, and US$150,000 for single filers.

EV Incentives and Initiatives at the State Level

While the Clean Energy Credit is the only incentive offered by the federal government for EV users, it is not the only available incentive for EV users. Most benefits and incentives for EV users are at the state level, provided by state governments, municipalities, or utilities. This means that the state in which EV users reside, as well as locations within the state, plays a role in their affordability and feasibility without considering factors such as the quantity of the EV infrastructure. The quantity and quality of the incentives depend on how much of a priority EV adoption increase is for the state and municipalities. Even within a state, this priority can greatly differ depending on the municipality.

EV incentives can be separated between financial and nonfinancial incentives. Incentives with a financial focus are offered in the form of rebates, low-interest loans, tax credits, and electricity rate reductions provided by state governments, municipalities, and utilities. These incentives serve to help with the affordability of EVs and offset any higher costs that may be associated with EV vehicle ownership, such as the initial vehicle costs and maintenance and increased utility power bills the user may expect to experience. These incentives are offered at both the residential level and commercial level. Incentives with a nonfinancial focus are offered in various quality-of-life applications, with some common examples including high-occupancy vehicle lane access, carpool lane access, and toll road access. Many specialty lanes blocked behind fees or vehicle classifications are modified to include EVs within qualifying states to provide quality-of-life benefits for EV users during

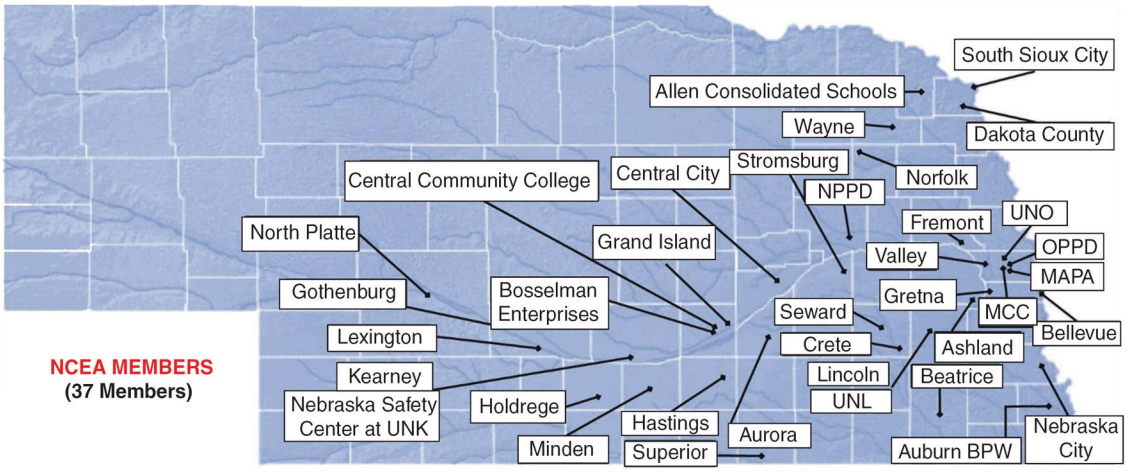

Figure 10. A Nebraska map showing the 37 NCEA participating members. (Note. Figure is author generated for NCEA.) OPPD: Omaha Public Power District; NPPD: Nebraska Public Power District; UNO: University of Nebraska Omaha; MAPA: Metropolitan Area Planning Agency; MCC: Metropolitan Community College; UNL: University of Nebraska–Lincoln; BPW: Board of Public Works.

their commutes and incentivize EV use for drivers looking for easier commutes on the road.

In the investigation of incentives available at the state level, the actions of Nebraska and the Nebraska Community Energy Alliance (NCEA) are used as a case study to provide an example of the effect that state and local government entities can have on EV adoption within the state. The NCEA was founded in January 2014 as an interlocal cooperative agency. Today, it has 37 participating members that span most of the State of Nebraska, as shown in **Figure 10**.

The mission of the NCEA is to build and promote advanced technologies for housing and transportation that save energy, reduce CO_2 pollution, and cut costs. This mission is clearly articulated by Lance Hedquist, city administrator for South Sioux City, the founder of NCEA, and a current member: "Communities have a choice to simply exist or to lead. Our projects demonstrate leadership and help motivate and excite our citizens." NCEA believes demonstrating the economic and air-quality benefits of advanced fuel vehicles at the local level is the best way to accelerate the market in Nebraska. This mission is being achieved in part using grant funding from the Nebraska Environmental Trust (NET) and

in compliance with the requirements of the air-quality funding category as well as NET's mission "to conserve, enhance and restore the natural environments of Nebraska."

Since 2014, NCEA has administered six grants focusing on the deployment and penetration of EVs and building a state-wide charging infrastructure for electrified transportation. The grants consisted of an approximately 50% match between the members and NET, the grant sponsor. These grants resulted in an estimated total of 55 EVs, nine compressed natural gas (CNG) vehicles, one refueling CNG station, 92 Level-2 ChargePoint™ networked charging stations, and seven ChargePoint dc fast-charging stations deployed across Nebraska. In addition, three NCEA utility members, the Omaha Public Power District (OPPD), Nebraska Public Power District (NPPD), and Fremont Municipal Utility, initiated a rebate program in each service territory to study the effects of EV charging on the grid and funded the deployment of an additional 293 EVs, 670 ChargePoint™ home charging stations, and 60 ChargePoint™ networked charging stations.

The effect of this effort, along with administering the various federal initiatives, by the State of Nebraska has resulted in a substantial increase in EVSE infrastructure and EV driver utilization. For example, data collected since 2013 show the number of unique users in Table 1. A unique user is a driver who may have charged one time or multiple times within a given time period. Once a new month starts, unique user counting will reset. Specifically, **Table 1** summarizes the cumulative yearly unique user data in terms of the number of unique drivers and charging sessions as well as the energy usage since the start of the data collection from April 2013 to 2022. **Figure 11**, **Figure 12**, and **Figure 13** show charging infrastructure installation and usage trends over the period of data collection (since January 2013).

Conclusion

In response to the popularity of EVs over the last few years, the federal government, state agencies, and public and private entities have taken actions to increase the rate of adoption and implementation of EVs and associated charging infrastructure. As EV usage increases, the U.S. government and state agencies can take active roles by ensuring that the EV

Table 1. A summary of unique user data, charging sessions, and energy usage. (Note. The table is author generated for NCEA.)

Year	*Number of Unique Users*	*Number of Charging Sessions*	*Energy Usage (kWh)*
2013	19	618	3,410
2014	45	1,003	4,940
2015	97	1,962	14,114
2016	211	2,825	23,871
2017	427	4,361	34,715
2018	756	7,148	61,136
2019	1,137	9,471	108,238
2020	1,250	7,228	88,426
2021	3,530	17,086	210,054
2022	6,680	32,742	447,361

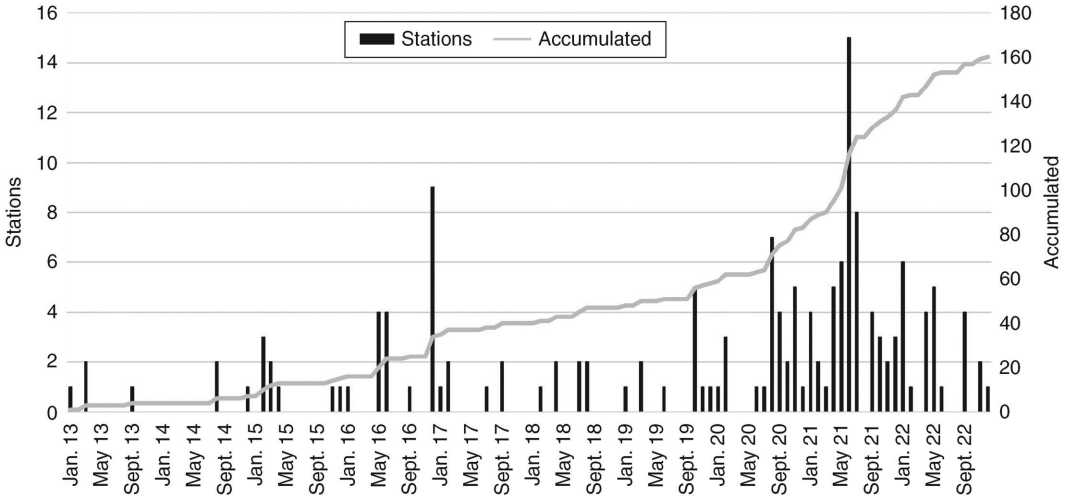

Figure 11. The number of charging stations installed per month since January 2013. (Note: Figure is author generated for NCEA.)

refueling infrastructure, regulations, and legislation in place are able to support this increased adoption as the absence of any of these necessary elements has a dampening effect on the public acceptance of EVs. The federal government has taken important steps to ensure that the EV refueling infrastructure is ready through notable actions such as the Volkswagen Mitigation Funding and BIL, both of which provided substantial funding to each state to build and support EV refueling infrastructure within their roadways and cities as per their jurisdiction.

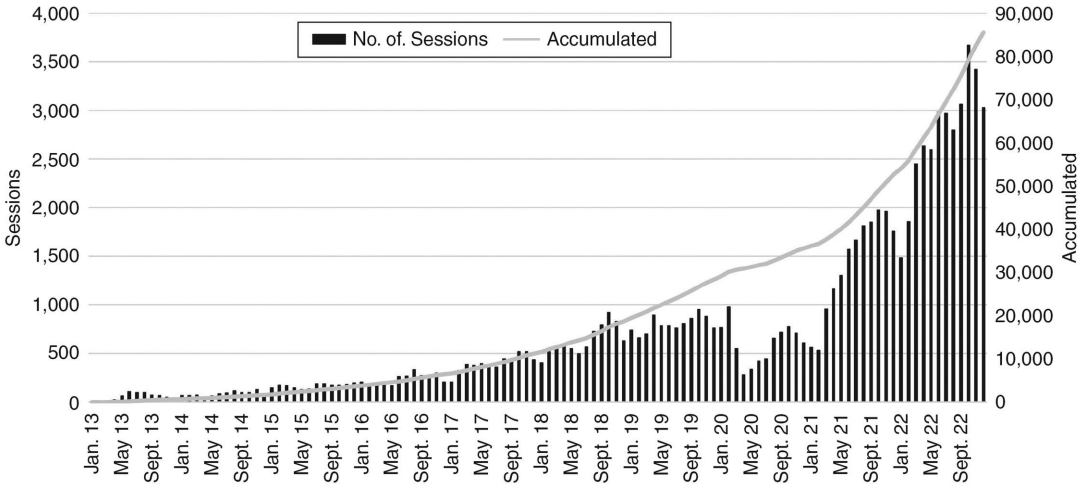

Figure 12. The number of charging sessions per month since January 2013. (Note: Figure is author generated for NCEA.)

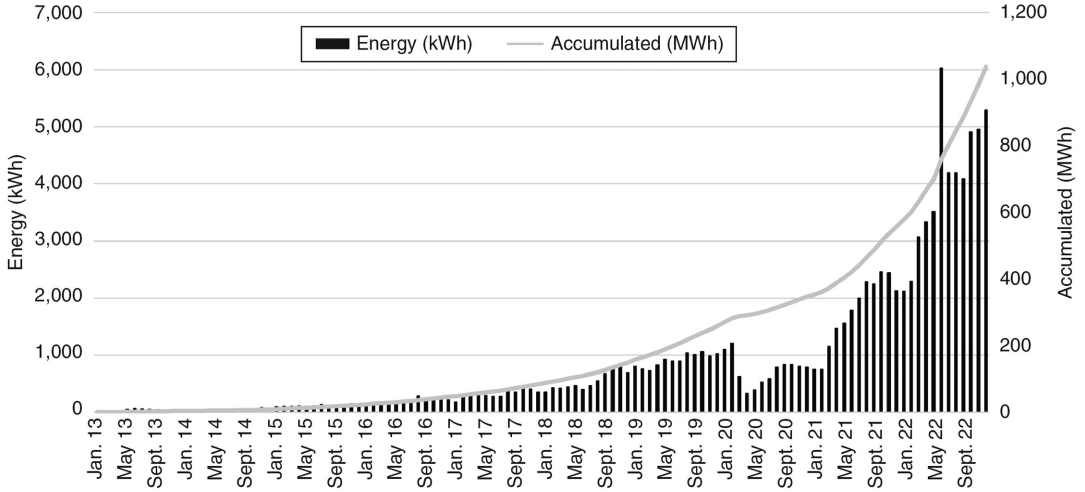

Figure 13. Energy usage per month since January 2013. (Note: Figure is author generated for NCEA.)

Ultimately, the readiness and extent of EV refueling infrastructure lie within each state. Additional opportunities to prepare for EV adoption are seen through legislation such as EV registration fees to counter a decrease in state road funding and by including a new reference to electrified transportation and the necessary supportive refueling infrastructure in each state's LRTPs.

For the public, incentives are available to offset the cost of EVs and make their adoption more affordable. All users receive a tax credit from the federal government through the Clean Vehicle Credit, with different allotments according to the qualifications of the user. Furthermore, several opportunities for financial benefits or nonmonetary benefits are available for EV users depending on the state of residence and utility provider of residence. One such local initiative in Nebraska offers an example in real time of the environmental benefits and economic savings of government investment in EVs, EV charging infrastructure, and the data collection to support it.

For a further extrapolation of this research, extensive documentation of other states can be conducted to study the EV market and charging data within each state and the benefits provided for their residents. With extensive familiarity of each state's priorities and cultures as well as their infrastructure and legislation, complete and exhaustive documentation of this can allow for cross-comparison between states or even regions of the United States and the effectiveness of their actions.

For Further Reading

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