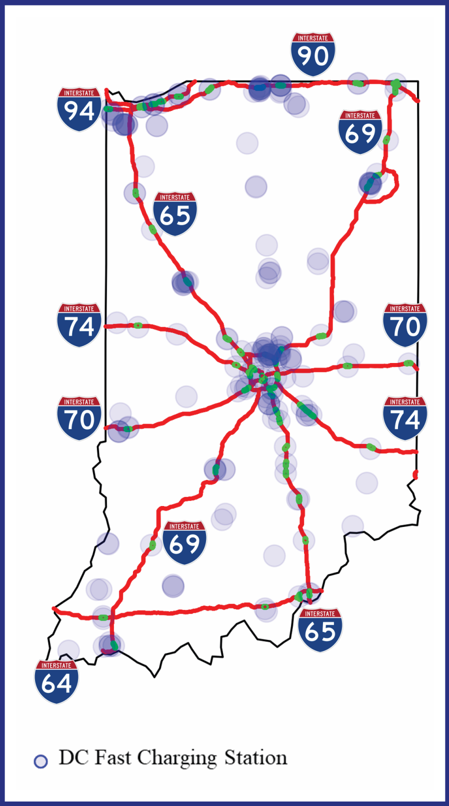
JOINT TRANSPORTATION RESEARCH PROGRAM

INDIANA DEPARTMENT OF TRANSPORTATION AND PURDUE UNIVERSITY

Development of Dashboards and Procedures for Using Connected Vehicle Data to Prioritize Investments in Electric Vehicle Related Infrastructure



Jairaj C. Desai, Nathaniel J. Sturdevant, George McCue, and Darcy M. Bullock

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AUTHORS

Jairaj C. Desai, PhD
JTRP Transportation Research Engineer
Lyles School of Civil and Construction Engineering
Purdue University
(765) 494-4544
desaij@purdue.edu
Corresponding Author

Nathaniel J. Sturdevant, PE
Emerging Mobility Director
Indiana Department of Transportation

George McCue
Emerging Mobility Assistant Director
Indiana Department of Transportation

Darcy M. Bullock, PhD, PE
Lyles Family Professor of Civil Engineering
JTRP Director
Lyles School of Civil and Construction Engineering
Purdue University

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7. Author(s)
Jairaj C. Desai, PhD (https://orcid.org/0000-0003-2885-203X)
Nathaniel J. Sturdevant, PE (https://orcid.org/0009-0004-2110-6389)
George McCue
Darcy M. Bullock, PhD, PE (https://orcid.org/0000-0002-7365-1918)

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Hall for Discovery and Learning Research (DLR), Suite 204
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West Lafayette, IN 47907

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16. Abstract
The National Electric Vehicle Infrastructure (NEVI) Formula Program and the Charging and Fueling Infrastructure Discretionary Grant Program together provide $7.5 billion to support states with building out a nationwide EV charging network. Indiana's Charging the Crossroads program, funded through the NEVI program, plans to invest almost $100 million to build an EV charging network along Indiana interstates and highways. There is broad consensus among states, that these fast charging station investments should be based upon quantitative geospatial data with the objective of maximizing the impact of the NEVI program investments.

However, traditional methods for monitoring electric vehicle (EV) usage have relied on time and cost intensive techniques that do not scale well. Travel diaries, surveys, camera detection and count stations are just some of the methods utilized in the past to monitor traffic volumes. Connected vehicle data with enhanced attributes have the potential to inform stakeholders of electric vehicle use at scale and year-round without additional fixed infrastructure or sensor investments. The motivation of this study was to explore the viability of CV data to provide data-driven insights to practitioners in helping prioritize the rollout of EV charging infrastructure.

The study utilized connected vehicle data to develop methodologies and reporting procedures that document usage of transportation and charging infrastructure by EVs. Additionally, the study utilized publicly available data on public fast charging station locations to determine fast charging deserts along AFCs.

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EXECUTIVE SUMMARY

Motivation

The National Electric Vehicle Infrastructure (NEVI) Formula Program and the Charging and Fueling Infrastructure Discretionary Grant Program together provide $7.5 billion to support states with building out a nationwide electric vehicle (EV) charging network (Joint Office of Energy and Transportation, n.d.). Indiana's Charging the Crossroads program, funded through the NEVI program, plans to invest almost $100 million to build an EV charging network along Indiana interstates and highways (Indiana Department of Transportation [INDOT], 2022). Figure 1 illustrates the rapid growth in public fast-charging station infrastructure in Indiana over the past 13 years. There is broad consensus among states, that these fast-charging station investments should be based upon quantitative geospatial data with the objective of maximizing the impact of the NEVI program investments.

However, traditional methods for monitoring EV usage have relied on time- and cost-intensive techniques that do not scale well. Travel diaries, surveys, camera detection and count stations are just some of the methods utilized in the past to monitor traffic volumes. Connected vehicle (CV) data with enhanced attributes have the potential to inform stakeholders of electric vehicle use at scale and year-round without additional fixed infrastructure or sensor investments. The motivation of this study was to explore the viability of CV data to provide data-driven insights to practitioners in helping prioritize the rollout of EV charging infrastructure.

Study

The study utilized CV data to develop methodologies and reporting procedures that document usage of transportation and charging infrastructure by EVs. Additionally, the study utilized publicly available data on public fast-charging station locations to determine fast-charging deserts along Alternative Fuel Corridors (AFCs).

Results

The following key findings and limitations emerged from this study:

- Traditional count stations capture traffic volume but provide no data that captures EV travel patterns.
- Bureau of Motor Vehicle data provide little visibility on where EV trips occur.
- Furthermore, no data on EV trip lengths or EV travel in the state from vehicles registered out of the state are available.

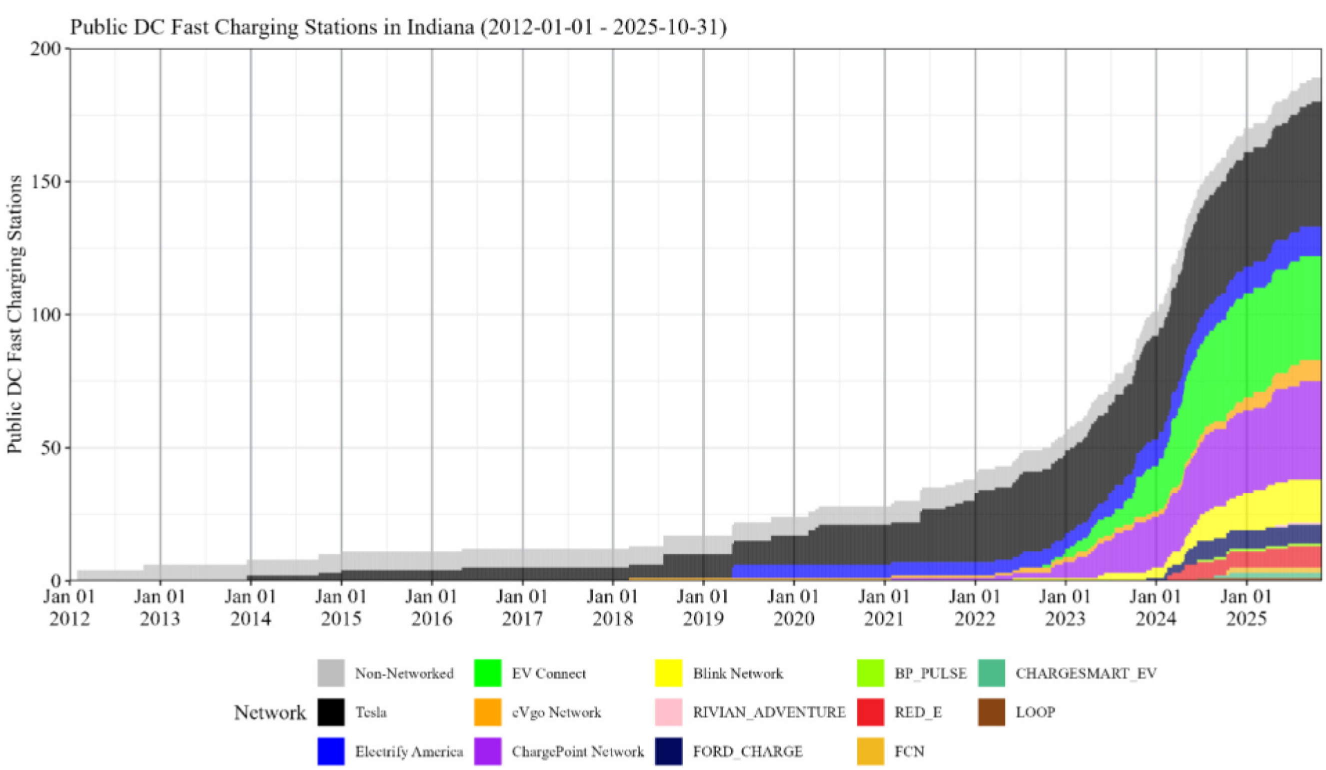

Figure 1 Public DC Fast Stations in Indiana (2012–2025).

- EV station locations are readily available. However, EV station charging session data have been difficult to obtain from the private sector, and it is unclear if any legislative or policy requirements are needed for this to occur.
- Charging deserts have been successfully monitored with a combination of public data and linear referenced routes prepared by this study.
- Vehicle miles traveled (VMT), as well as trips for EVs, were obtained using CV data; however, evolving privacy challenges and changing filtering procedures in this space may reduce the viability of this data.
- Charge status is monitored by EV original equipment manufacturers (OEMs), but it is unlikely that they will want to share this data at scale.

Recommendations

The methodologies and reporting visualizations developed by this study are scalable to any geographic location provided the availability of corresponding CV data. The study team recommends regular monitoring of EV use along AFCs as well as statewide to help quantify return on investment in charging infrastructure placement and understand how EV travel trends differ from traditional vehicles using real-world data. As the market penetration rate of CVs continues to grow and more OEMs are added to the fleet, the representativeness of the data and its usefulness for EV monitoring will continue to increase.

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1. PROJECT OVERVIEW

1.1 Introduction

Countries around the world recognize the significant sustainable transportation benefits that Electric Vehicles (EVs) provide (Alanazi, 2023) and have thus provided extensive funding to prepare their transportation infrastructure (Singh et al., 2023) to accelerate EV adoption. A significant body of existing literature has documented the public health and environmental benefits of EVs towards reducing greenhouse gas emissions and addressing climate change (Alanazi, 2023; Buekers et al., 2014; Holland et al., 2016; Li et al., 2015), the economic benefits (Bauer et al., 2021; Patil & Kalkhambkar, 2021), and how closely a sustainable transportation future outlook is intertwined with growth in EV adoption and smart grid management strategies (Adnan et al., 2018; Kene et al., 2021). A robust and scalable data-driven methodology and related performance measures, such as those presented by this study, are vital to enable such informed infrastructure investment decision making to ensure sustainable transportation-focused practices in the future.

The National Electric Vehicle Infrastructure (NEVI) Formula Program and the Charging and Fueling Infrastructure Discretionary Grant Program together provide $7.5 billion to support states with building out a nationwide EV charging network (Joint Office of Energy and Transportation, n.d.). Indiana's Charging the Crossroads program, funded through the NEVI program, plans to invest almost $100 million to build an EV charging network along Indiana interstates and highways (INDOT, 2022). Figure 1.1 illustrates the already rapid growth in public fast-charging station infrastructure in Indiana over the past 13 years. States across the US will need a data-driven approach towards allocating this program funding to optimize infrastructure siting.

This study was initiated to evaluate the feasibility of using connected vehicle (CV) data to develop scalable methodologies and reporting practices that can provide data-driven insights to stakeholders on EV usage in the state of Indiana, and is structured as follows:

- Section 1: Provides an overview of the project's scope and objectives.
- Section 2: Provides a literature review of traditional methods of EV usage monitoring and emergence of CV data.
- Section 3: Describes the various data sources used in the analysis.
- Section 4: Describes the various methodologies developed as part of this study.
- Section 5: Summarizes the results of the analysis in the context of both vehicle miles traveled (VMT) and fast-charging deserts.
- Section 6: Provides key findings, conclusions, and limitations from this research.
- Section 7: Provides an outlook on future research directions that could be adopted.

1.2 Scope and Objectives

With an impending shift in the automobile industry towards alternative fuel vehicles, agile monitoring of trip trends and infrastructure utilization for both internal combustion engine

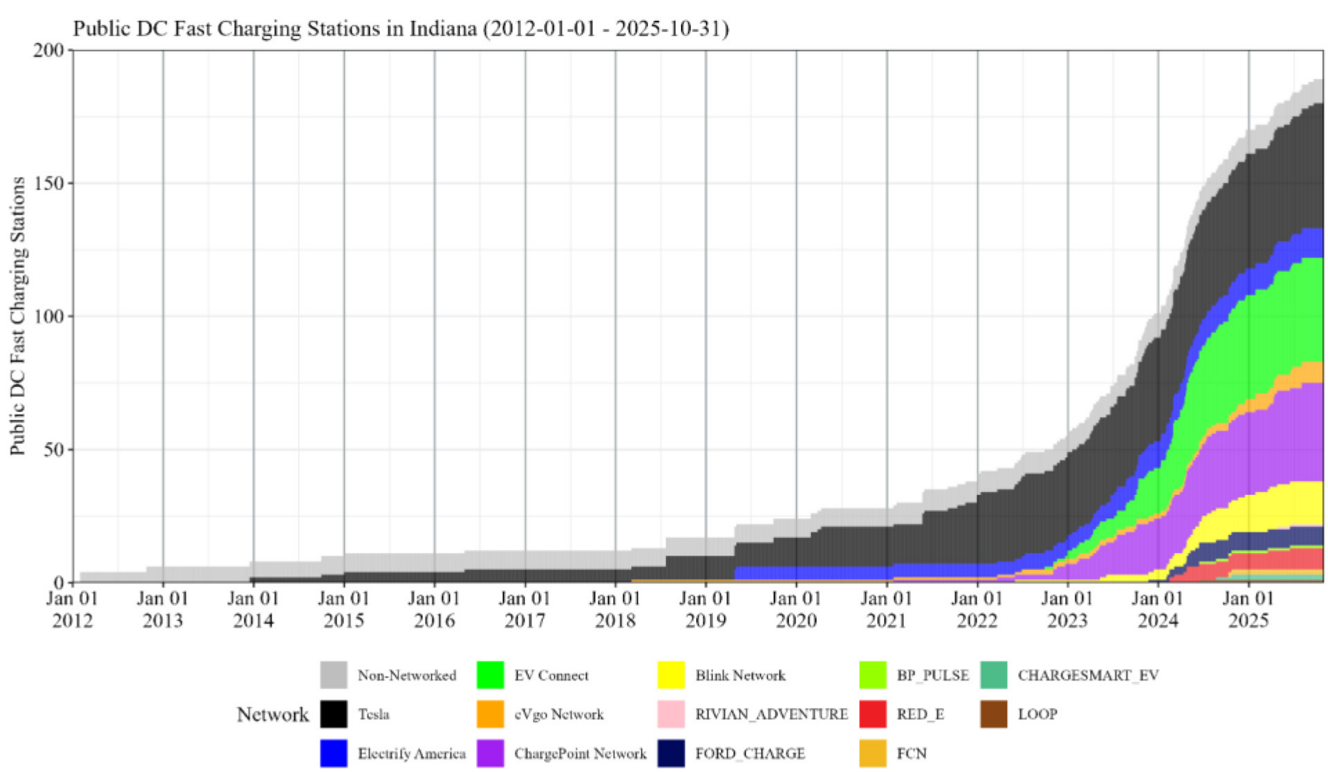


Figure 1.1 Public DC Fast Stations in Indiana (January 2012–October 2025).

vehicles (ICEV), as well as hybrid vehicles (HV) and EV, is important to help guide state and national investments in alternative fuel infrastructure. The objectives of this study were broadly two-fold:

- Utilizing CV data to develop methodologies and reporting procedures that document usage of transportation and charging infrastructure by EVs, and
- Utilizing publicly available data on public fast-charging station locations to determine fast-charging deserts along AFCs.

Figure 1.2 shows a summary overview of the CV data footprint available as part of this study in terms of monthly interstate vehicle miles traveled by ICEVs, EVs, and HVs for 34 months. During the period of June 2023 to May 2024 there was a brief outage in CV data due to changes in the data provider market.

1.3 Dissemination of Research Results

The following research studies, listed in chronological order, were prepared in part during or in preparation for this project to facilitate an agile dissemination of results for public- and private-sector stakeholders:

- Desai, J., Mathew, J. K., Li, H., & Bullock, D. M. (2021). Analysis of electric and hybrid vehicle usage in proximity to charging infrastructure in Indiana. *Journal of Transportation Technologies*, *11*(4), 577–596. https://doi.org/10.4236/jtts.2021.114036
- Desai, J., Mathew, J. K., & Li, H. (2022). Using connected vehicle data for assessing electric vehicle charging infrastructure usage and investment opportunities. *Institute of Transportation Engineers. ITE Journal*, (3), 22–31.
- Desai, J., Mathew, J. K., Li, H., & Bullock, D. M. (2022). Leveraging connected vehicle data to assess interstate exit utilization and identify charging infrastructure investment allocation opportunities. *World Electric Vehicle Journal*, *13*(9), 167. https://doi.org/10.3390/wevj13090167
- Desai, J., Mathew, J. K., Li, H., Sakhare, R. S., Horton, D., & Bullock, D. M. (2022). *National mobility analysis for all interstate routes in the United States: December 2022*. Purdue University. https://doi.org/10.5703/1288284317591
- Mahlberg, J. A., Desai, J., & Bullock, D. M. (2023). Evaluation of electric vehicle charging usage and driver activity. *World Electric Vehicle Journal*, *14*(11), 308. https://doi.org/10.3390/wevj14110308
- Desai, J., Mathew, J. K., Mahlberg, J. A., Li, H., & Bullock, D. M. (2023). Using connected vehicle data to evaluate national trip trends. *Applied Sciences*, *13*(18), 10228. https://doi.org/10.3390/app131810228
- Desai, J., Mathew, J. K., Sturdevant, N. J., & Bullock, D. M. (2024). Longitudinal monitoring of electric vehicle travel trends using connected vehicle data. *World Electric Vehicle Journal*, *15*(12), 560. https://doi.org/10.3390/wevj15120560

A majority of the contents of this report are adapted from the aforementioned research papers (Desai et al., 2021, 2022a, 2022b; Desai, Mathew, Li, et al., 2023b; Desai, Mathew, Mahlberg, et al., 2023; Desai et al., 2024; Mahlberg et al., 2023).

Furthermore, the findings from this study were presented to stakeholders over the course of this project at various Study Advisory Committee (SAC) meetings and engagement events,

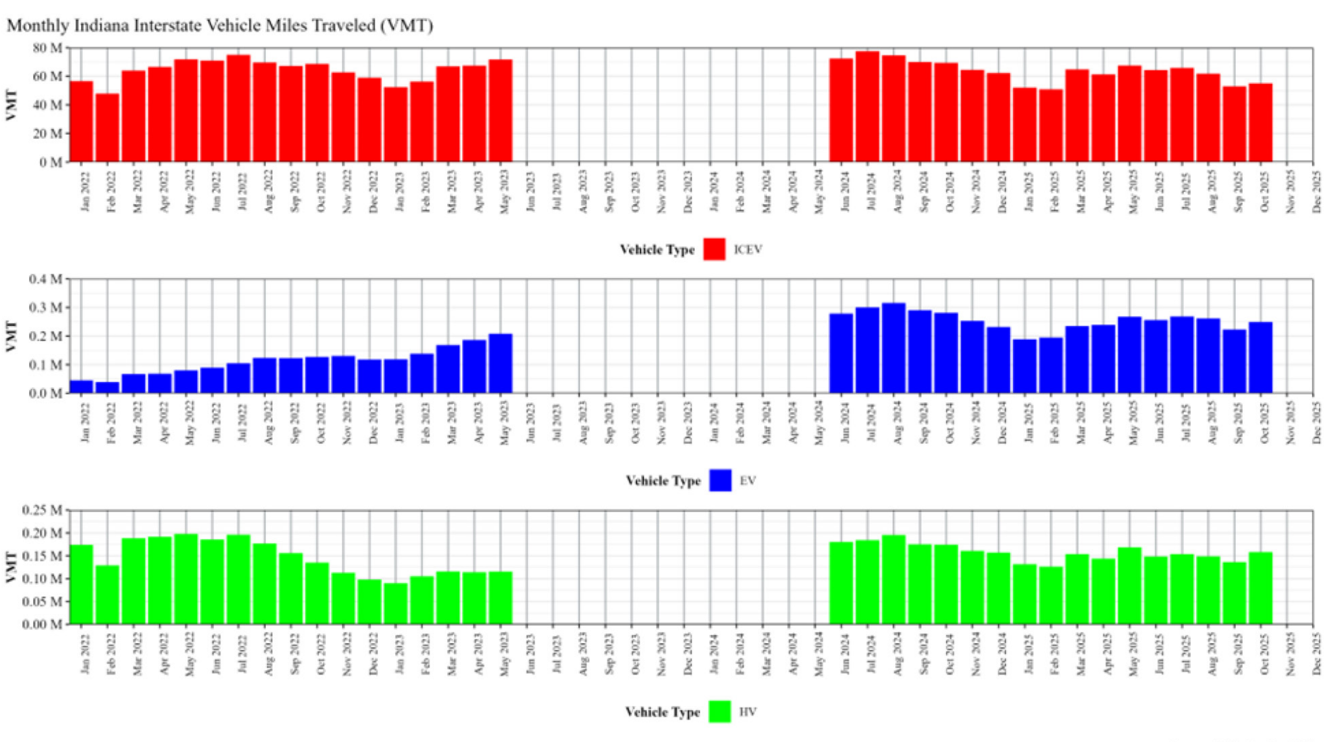


Figure 1.2 Indiana Interstate VMT (January 2022–October 2025).

including lectern presentations during the 2025 edition of the Purdue Road School Transportation Conference and Expo. The following sections of this technical report summarize the background and key findings of this research.

2. LITERATURE REVIEW

Historically, agencies have used several different approaches to estimate VMT and forecast VMT growth, including traffic-count-station data (Puentes & Tomer, 2008; Rentziou et al., 2012), socio-economic-data-based methods (Fricker & Kumapley, 2002; Liu et al., 2006), and demand forecasting models (Bhat & Nair, 2000; Szekeres et al., 2012). Each of these aforementioned VMT estimating methods have limitations, including low sampling rates, sampling bias, self-reporting bias, as well as the cost- and time-limitations associated with installing fixed infrastructure along a road network, such as traffic-count stations. In the context of EVs, VMT is a particularly important performance measure for assessing EV adoption and road use to help agencies prioritize corridors to invest in and track the impacts of their investment. Recently, large-scale CV trajectory data have been utilized to estimate VMT and have shown promising results in being able to compute accurate VMT estimates (Desai, Mathew, Li, et al., 2023a; Fan et al., 2019). A 2022 study utilized CV data (a pilot study with vehicles retrofitted with onboard equipment for data collection) to document the longitudinal impact of the pandemic on activity travel (Concas et al., 2022). Similar to VMT estimation, practitioners have utilized travel demand modeling, stochastic simulations (Wang et al., 2017), self-reported trip diaries (Tamor et al., 2015), Bluetooth matching (Jedwanna & Boonsiripant, 2022), and other techniques to estimate trip lengths (and corresponding trip durations) for vehicles passing through selected corridors or construction zones. However, limited research exists in using large-scale CV data towards estimating trip lengths at a statewide level in a scalable framework, which is one of the research gaps that statewide CV data can help fill.

Over the past several years, CV data have emerged as a viable alternative to traditional methods to support performance measurement efforts in a variety of domains including construction work zones, before–after safety studies, winter operations, among others. CV data, typically reported at 1–60 s intervals, has been used for a wide variety of use cases in transportation engineering (Sakhare et al., 2024; E. Saldivar-Carranza et al., 2023), including in the field of alternative fuel infrastructure and EVs (Desai et al., 2022b).

As countries, states, and agencies around the globe prepare for the transition to an EV-heavy fleet (Chu & Cui, 2023; Slowik & Lutsey, 2018), quantitative evidence supporting stakeholder investments is very important. A number of studies in this domain have focused on electric-vehicle charging infrastructure availability (Brown et al., 2024) and utilization (Borlaug et al., 2023; Gellrich et al., 2022; Hecht et al., 2022) trends and how charging infrastructure deployment relates to EV use. Those studies have shown promising results in utilizing these data for informing charging-station infrastructure investments. Automotive Original Equipment Manufacturers (OEMs) already utilize these data in one form or another to guide users to their nearest charging stations, or in trip planning, among other such applications. There is, however, a growing need for a common dialogue among the private- and public-sector stakeholders to develop a shared vision on VMT-oriented performance measures that ensure user privacy and provide the necessary data for both public agencies and the private-sector stakeholders for making informed decisions on charging infrastructure deployment.

The provision of a vehicle classification code in CV data feeds, or a corresponding classification flag, has enabled use cases for CV data in the alternative fuel vehicles domain, as well. Basic attributes alone, such as time-stamped geolocations of EVs, can significantly help improve understanding of EV travel trends, preferred routes, distances driven, use of public or private charging infrastructure.

3. DATA DESCRIPTION

The three main sources of data used by this study can be segmented into the following categories:

- CV data,
- charging station locations, and
- a linear referenced route network to be analyzed.

Each of these are described in detail in the text that follows.

3.1 CV Data

Commercially available crowdsourced CV data were obtained from two third-party data providers for this study. The data contained geolocation, speed, heading, and timestamp information for CVs at approximately 3 s frequency and 3 m geolocation accuracy. Past studies have found these data to have an average market penetration rate, across all classes of vehicles, of 4–6% (Hunter et al., 2021; Sakhare et al., 2022; Saldivar-Carranza et al., 2024). Along with the aforementioned attributes, each CV waypoint also contained an anonymized journey identifier as well as an additional classification attribute, which allows for categorizing the vehicle either as an EV, HV, or ICEV. For the 34-month study period designated for this analysis from January 2022 through October 2025, a total of nearly 374 billion CV records were analyzed.

3.2 Charging Station Locations

Using the National Laboratory of the Rockies (2025), formerly the National Renewable Energy Laboratory's (NREL) alternative fuel stations API, geolocation data for alternative fuel stations and multiple other pertinent attributes including number of charge points may be obtained. Figure 3.1 shows a view of the 190 public access fast-charging stations in Indiana as of November 19, 2025.

3.3 Linear Referenced Route Network

Indiana's October 2023 update of the Electric Vehicle Infrastructure Plan noted the current Alternative Fuel Corridor (AFC) network covering all interstates as well as US 31. Seven

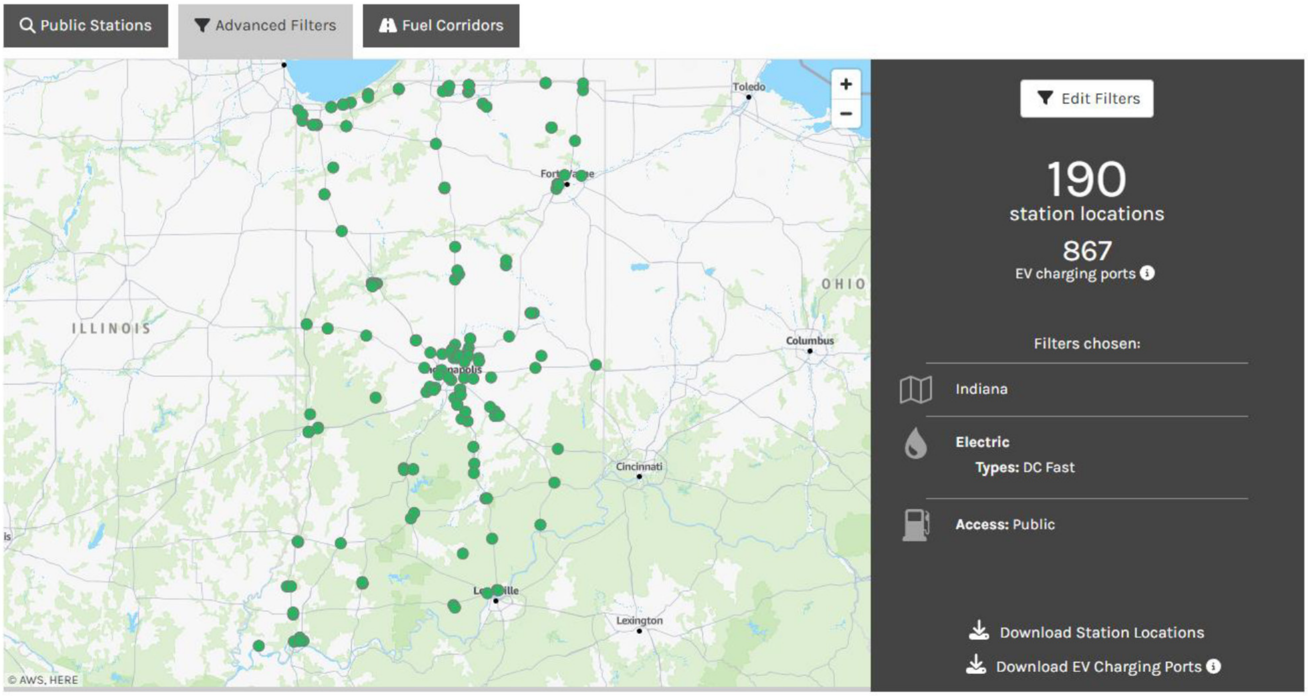


Figure 3.1 Alternative Fueling Station Locations Showing 190 DC Fast Public Station in Indiana (Alternative Fuels Data Center, n.d.).

other routes were being considered in Round 7 of AFC nominations including US 30, US 50, US 41/SR 63, SR 62 and SR 66, SR 930, US 36, US 40. In order to be able to accurately determine the evolution of gaps in charging accessibility along these and other future selected corridors in the state, the study team prepared a linear referenced network of all interstates, US routes, as well as state routes in Indiana. This route network is depicted on the map shown in Figure 3.2. Having this persistent route network, with segment granularity as low as 0.02 mi, aids in longitudinal monitoring of fast-charging availability as new stations continue to become operational over the coming years.

4. METHODOLOGY

This section discusses briefly how practices on classifying EV data from a stream of CV data have evolved with changes in the data provider marketplace. Furthermore, various methodologies developed as part of or in preparation for this study to estimate vehicle miles traveled, trip length, trip duration, interstate exit utilization, charging station utilization and fast-charging deserts are briefly summarized. While some of these methodologies may not yield representative results due to several factors including CV market penetration rates and low overall EV penetration, these novel scalable techniques will be crucial over the coming years as both continue to rise.

4.1 Identifying EV Data

CV data utilized by this study has significantly evolved over the past several years. Early CV data contained a vehicle classification code attribute with each waypoint. This vehicle classification code was then cross referenced with the National Highway Traffic Safety Administration's (NHTSA, n.d.) Product Information Catalog Vehicle Listing (vPIC) Application Programming Interface (API) to obtain the electrification level associated with it. If the electrification level obtained is *BEV (Battery Electric Vehicle)*, the vehicle classification code and subsequently the associated waypoint is flagged as belonging to an electric vehicle. A similar classification process is followed for hybrid vehicles, as well (Figure 4.1).

However, the recent re-emergence of CV data beginning June 2024 has resulted in the degradation in the fidelity of this vehicle classification code, and instead a separate attribute classifying a waypoint as EV, HV, or ICE is directly available from the data provider. Thus, the cross-referencing and decoding steps are no longer necessary.

4.2 Vehicle Miles Traveled

For each CV, whose records are connected by an anonymized journey identifier, pairwise distances between consecutive CV waypoints were computed. These traveled distances were then aggregated at the county level to compute statewide VMT, and summary statistics from the same have been visualized and discussed in the text that follows. Pairwise distances with a maximum gap of 3 s and a distance traveled of less than 0.1 mi between waypoints (corresponding to a speed of 120 mph), were used for this analysis to remove outliers and errors in data reporting and maintain consistency across multiple data providers and timeframes. These thresholds for filtering pairwise distances were selected as reasonable tolerances for capturing

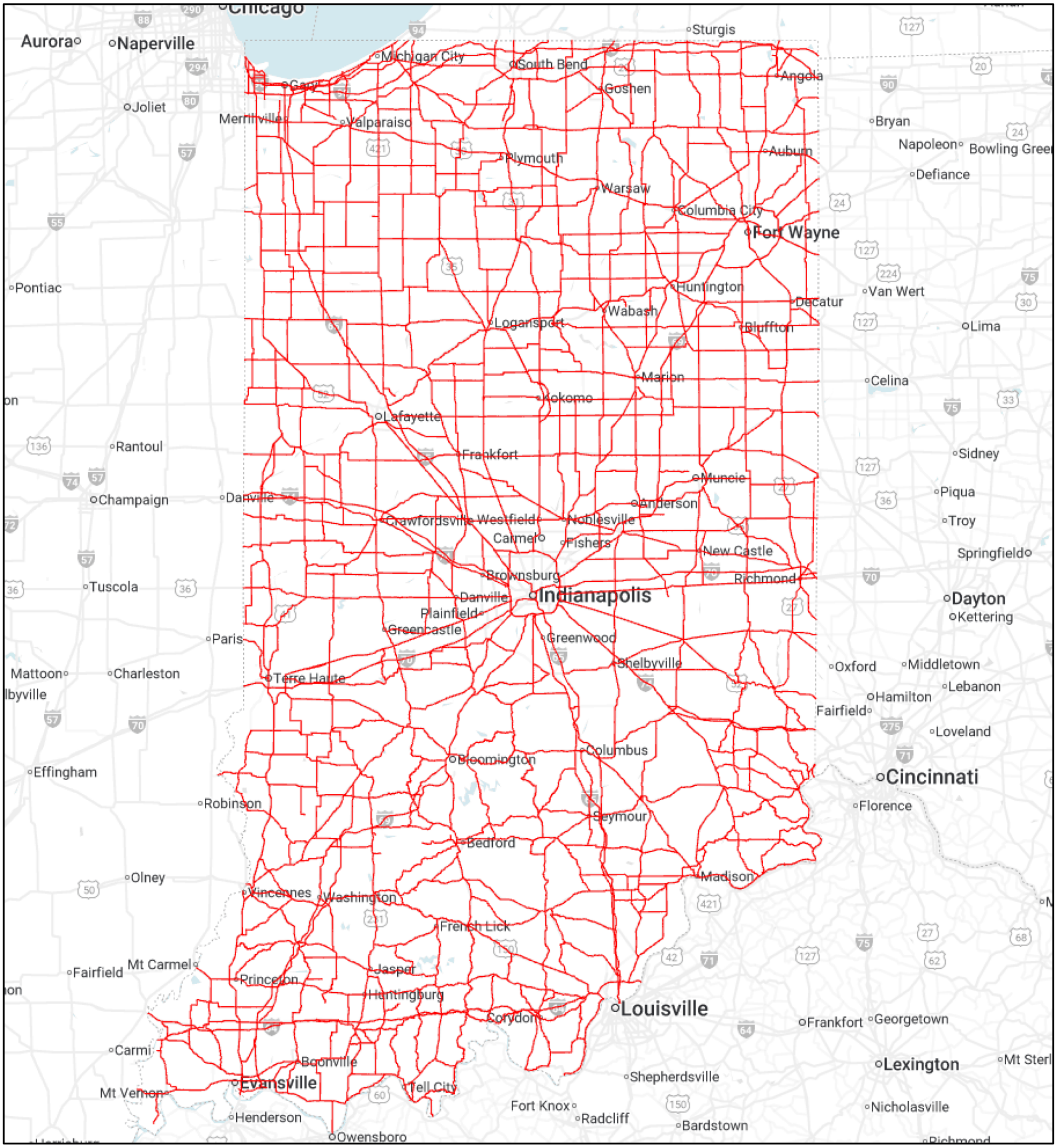


Figure 3.2 Indiana's Interstate, US, and State Route Network.

distances along curves but may be easily modified according to future study requirements. For example, CV data providers may transition to more frequent waypoint reporting in the future or may provide enhanced attributes such as odometer values, both of which will help improve the accuracy of VMT estimation.

A summary visualization of estimated statewide VMT, as observed by CVs compared year over year for the month of April between 2022 and 2023 is shown by Figure 4.2, with VMT being represented on the vertical axis in millions. The graphic shows that EV miles traveled (EVMT) grew in the state year over year by about 156%, while ICEV miles traveled (ICEVMT) grew only by about 2%. HV miles traveled (HVMT) were seen to have declined year over year by approximately 41%, a change mostly like due to changes in OEM fleet composition in the

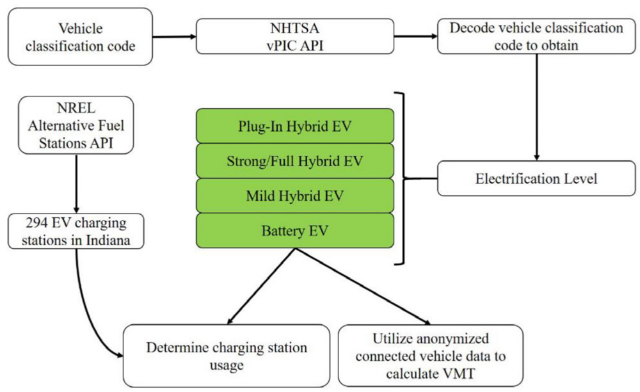


Figure 4.1 Methodology for Decoding Vehicle Classification Code to Isolate EV and HV CV Data (Desai et al., 2021).

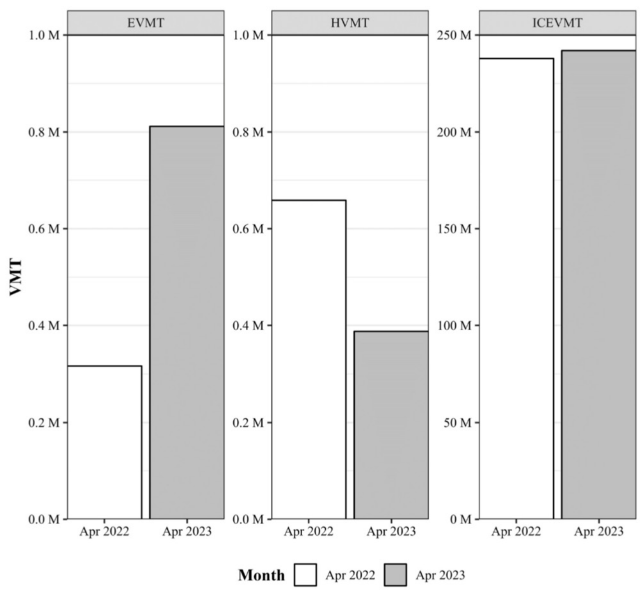


Figure 4.2 Statewide Vehicle Miles Traveled by Vehicle Type (April 2022 and April 2023) (Desai et al., 2024).

data. A limitation of this study was the lack of visibility regarding OEM fleet composition changes between years and data providers, which future research may look to improve upon.

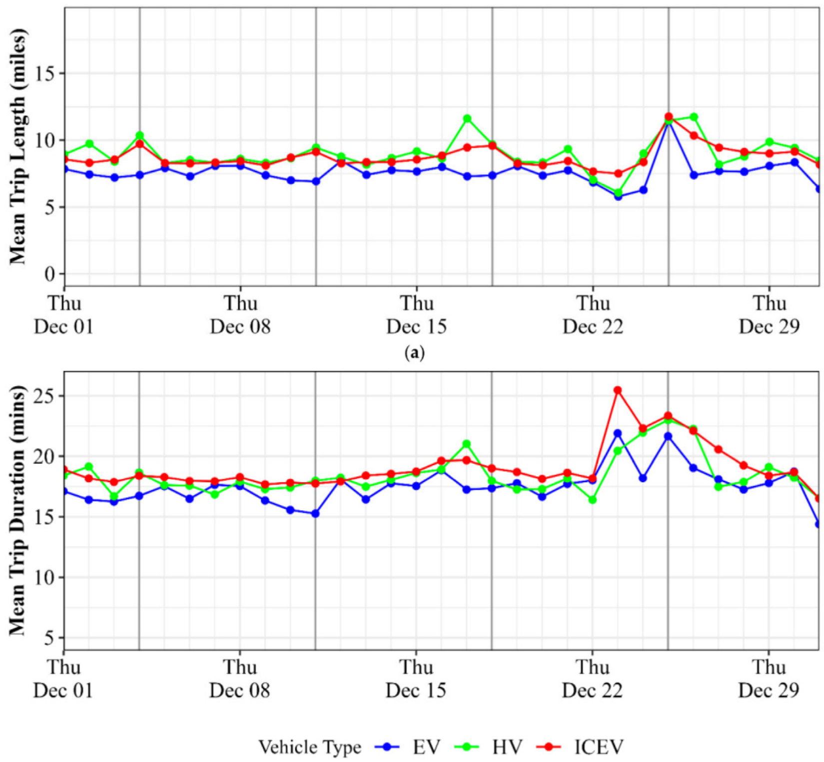
4.3 Trip Lengths and Trip Durations

For each CV journey, the chronological first and last waypoints can be easily identified. These waypoints are treated as the origin and destination for the journey, respectively, and are referred to as such in the text that follows. The corresponding origin and destination geolocations are spatially joined to a publicly available dataset of census block groups. CV journeys whose origin has an associated ignition status of "key on" and a destination that has a corresponding ignition status of "key off" are selected to ensure only complete journeys are analyzed. Gaps in time between consecutive waypoints along a journey, beginning with the origin and ending at the destination, are recorded with their summation representing the trip duration and maximum value documented. The minimum time gap between waypoints was observed to be 1 s. Only journeys with a maximum time gap of 10 s between consecutive waypoints are considered. Similarly, great-circle distances between consecutive waypoints along a journey, beginning with the origin and ending at the destination, are recorded with the sum representing the estimated trip length and maximum value documented. Journeys with a maximum distance gap of 0.75 mi between consecutive waypoints are considered for this analysis. These spatial and temporal thresholds for filtering journeys may be modified as needed per the demands of the analysis and were selected to account for a reasonable tolerance of GPS errors as well as missed data points due to connectivity issues. Finally, only those CV trips that included at least two waypoints over a non-zero time period were selected. Insights into trip trends with very short or near-zero estimated lengths, enabled by these thresholds and waypoint level granularity, are valuable for policymakers in tracking emissions due to idling vehicles, a traditionally unattainable performance measure using survey methods, and especially important to longitudinally monitor the industry's shift towards alternative fuel vehicles. This methodology was utilized to reduce nearly 500 billion CV waypoint records nationwide into an aggregated set of nearly 1 billion CV trip records for a national study for December 2022 (Desai, Mathew, Mahlberg, et al., 2023).

Daily trip statistics provide visibility into how day-of-week travel patterns differ across the country as well as by time of year. About 23 million CV trips were recorded to be originating in Indiana in December 2022, and the corresponding daily mean values of trip length and trip duration are shown in Figure 4.3a and Figure 4.3b, respectively. The highest mean trip length observed for Indiana was 11.76 mi for Christmas Day and the highest mean trip duration observed was 25.47 min for 23 December, one of the days when Indiana was severely impacted by a winter storm event characterized by an arctic cold front (National Weather Service, n.d.). On average, Indiana recorded mean trip lengths of 8.93 mi for HVs, 8.66 mi for ICEVs, and 7.59 mi for EVs. ICEVs were observed to be driven for the longest time on average, with a mean trip duration of 18.82 min for the month. Weekday trip length and trip duration trends are fairly repetitive, while most higher trip lengths are visible over the weekends.

4.4 Interstate Exit Utilization

Given a comprehensive dataset of CV waypoints for the state of Indiana, the first step to reduce the waypoint data down to exit-level metrics is analyzing every single CV trajectory to determine points of ingress and egress off of an interstate route. The methodology proposed involves a set of polygons, each 0.1 mi in length, along the direction of travel of a roadway pointed to by Callout ii in Figure 4.4. A CV trajectory's overlap is determined with this set of polygons, enabling the detection of the point of departure for a journey when it leaves the interstate. This linearly referenced set of polygons allows a near-exact detection of the mile marker, and thus the corresponding exit, at



(b)

Figure 4.3 Daily Trip Statistics for Indiana (December 2022): (a) Mean Estimated Trip Length and (b) Mean Trip Duration (Desai, Mathew, Mahlberg, et al., 2023).

Figure 4.4 Sample CV Trajectory Departing I-64 at Exit 92 Showing Methodology for Detecting Exit Usage (Desai et al., 2022a).

which a journey joined or left the interstate route. For the sample journey shown by the red waypoints in Figure 4.4, Callout i shows the point at which the journey departs the interstate. Hence, using this methodology for the sample CV trip shown in Figure 4.4, it can be classified as having exited off of Interstate 64 (I-64) at Exit 92.

Using the aforementioned methodology, a comprehensive analysis may be conducted for all interchanges in a state's road network and results from the same have been documented in detail in (Desai et al., 2022a). Techniques such as these aid in documenting current interchange utilization trends by vehicles and help future infrastructure siting decisions as the market penetration of EVs continues to grow.

4.5 Charging Station Utilization

To develop methodologies that preserve privacy yet provide quantitative insights and data to decision-makers, a radius-based approach is proposed for estimating charging station utilization. The map view in Figure 4.5 illustrates the basic concept of this methodology. The center of the red circle represents the reported geolocation of a fast-charging station in Lafayette, Indiana. Solid red dots represent EV waypoints detected within a 100-ft radius of the station on June 1, 2025. By documenting the amount of time spent by an EV inside this detection radius—both stationary and moving, it can be estimated how long an EV was using the charging station, or, waiting for a charging spot to open up. While this methodology can estimate utilization it does not provide confirmation a vehicle was plugged in and charging. In an ideal scenario, charge session data from the station provider and charge status data from the OEMs could together fuse well to provide a much more accurate view of infrastructure utilization. Access to such data could very well open up new insights on charging accessibility, grid usage, capacity constraints, among others.

4.6 Fast-Charging Deserts

Using the linear referenced route network earlier described, a route-by-route analysis may be conducted to determine portions of the route where a fast-charging station exists within a

Figure 4.5 Radius Based Method of Estimating Charging Station Usage.

1-mi radius of the route. Once such sections are found, gaps in these sections along a route are classified as fast-charging deserts. The 1-mi threshold is based upon initial NEVI guidance but may well be adjusted to larger radii as per an agency's requirements. For example, an October 2021 study which performed sensitivity analysis on this radius showed that 96% of all DC fast-charging stations were within 6 mi of an interstate in Indiana (Desai et al., 2021).

Figure 4.6 shows a schematic explaining the methodology used to estimate fast-charging deserts by way of a sample north-south interstate route, I-65 in Indiana. Translucent blue circles indicate fast-charging station locations around the state. Solid green sections on the map as well as the accompanying column plot indicate sections of I-65 within 1-mi of a fast-charging station. Correspondingly, sections in red indicate those parts of I-65 that are not within 1-mi of a fast-charging station. Once this matching is systematically performed along a route, fast-charging desert sections start to emerge, such as the one highlighted from about mile marker (MM) 5 to MM 112. This technique can then be applied statewide or even across state borders and is covered further in Section 5.2.

5. RESULTS

While the preceding text covered a number of different methodologies to estimate a variety of performance measures relating to EVs, this study recommends two main outputs that can be easily tracked longitudinally, namely, VMT and fast-charging deserts. The following text describes these outputs further.

5.1 Longitudinal VMT Monitoring

Using a similar methodology as described for the statewide VMT analysis in Section 4.2, this can be repeated for the interstate route network in Indiana. This allows stakeholders to easily view and compare estimates of interstate VMT (assumed surrogate for long range travel) with non-interstate VMT (assumed surrogate for shorter local travel) for ICE, EV and HVs. Currently, there is substantial uncertainty of how long selected OEM's will be providing raw CV data directly to state agencies, largely due to privacy concerns. However, the techniques defined in this report define a framework that OEMs could quite easily use to compute those metrics. Ultimately, market forces and regulatory decisions will shape how close to the vehicle or OEM those metrics are calculated.

5.1.1 Interstate VMT

By estimating the distance traveled by all CV waypoints on Indiana's interstate system on a monthly basis, the following longitudinal visualization (Figure 5.1) of ICE, EV and HV VMT can be generated. The 12-month period of June 2023 to May 2024 indicates a brief outage in CV data when the data provider market was undergoing a change. Additionally, there

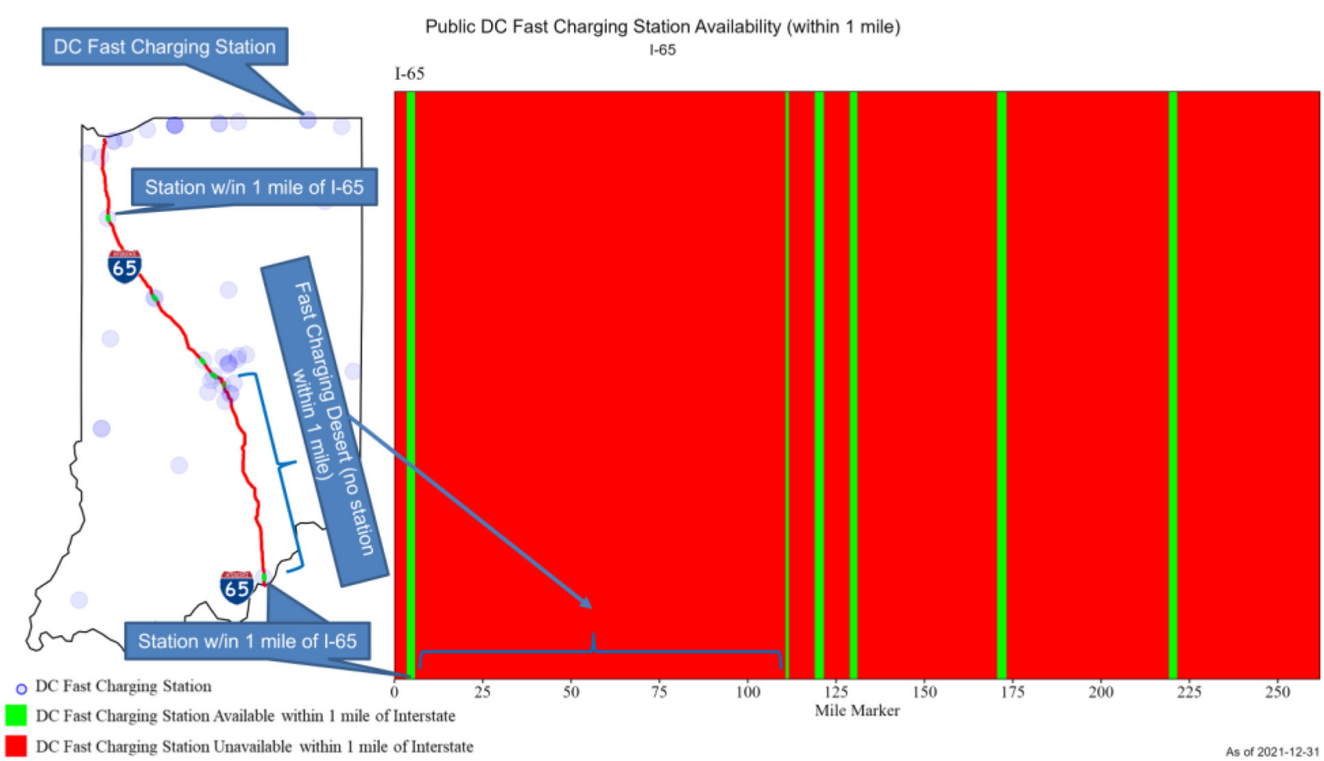


Figure 4.6 Indiana I-65 Fast-Charging Deserts.

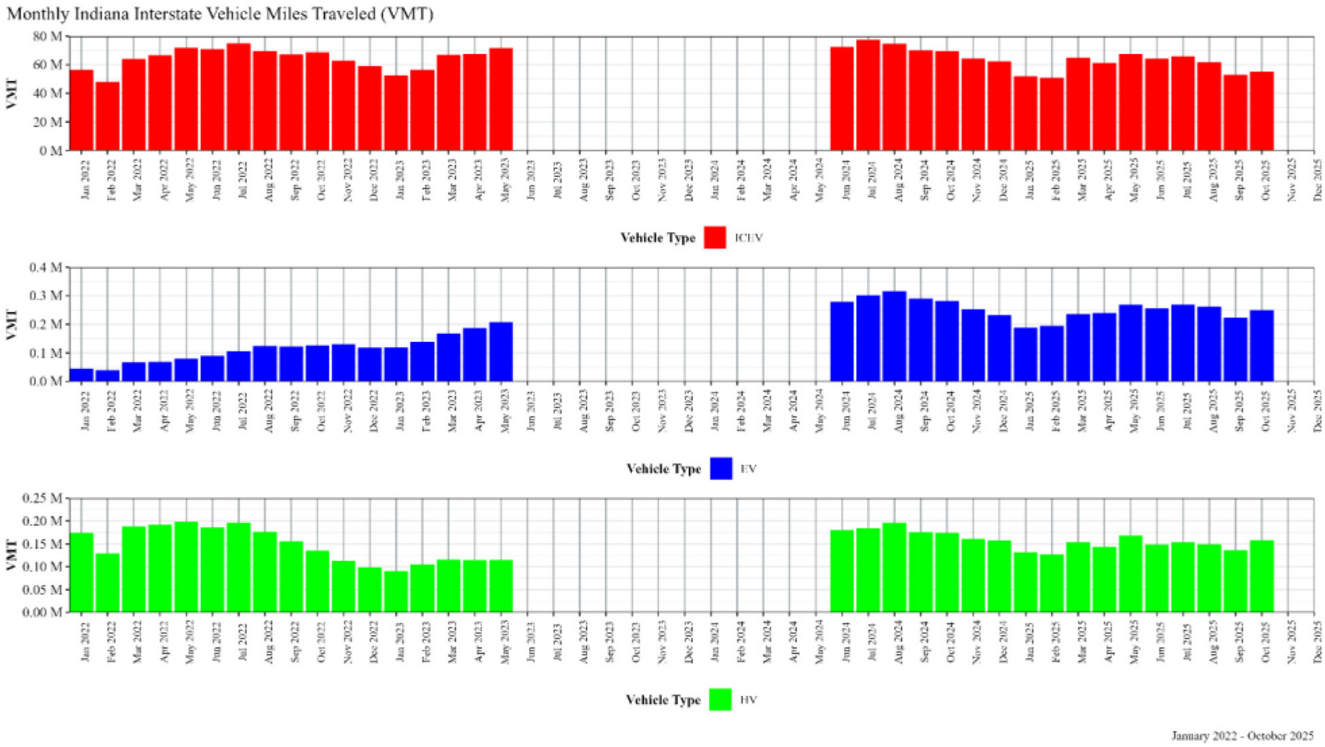


Figure 5.1 Indiana Interstate VMT (January 2022–October 2025).

is a small fraction of waypoints that could not be classified as belonging to any of the three categories, and they have hence been omitted from the results presented in this section. EVMT showed a steady rise while ICEVMT appears to have remained relatively stable from 2022–2024, however, privacy filtering practices among data providers have evolved over the past year possibly leading to the slight downtrend in VMT from June 2024 to June 2025 and beyond.

5.1.2 Non-Interstate VMT

Similarly, VMT on non-interstate routes can be computed by removing the interstate VMT from the statewide total. Monthly totals for the same colored by Indiana county are shown by Figure 5.2. For ease of reference, six specific counties, representing the highest total VMT around the state, have been highlighted by distinct colors and called out on the figure, namely, Allen, Hamilton, Lake, Madison, Marion and Porter. While this graphic utilizes a county-level geographic aggregation, this approach may be tweaked to another level such as zip codes or census block groups while balancing privacy protections and enabling higher reporting granularity for more localized insights.

These longitudinal VMT measurements, however, need to be placed in the broader context of the changing CV data provider market. As data providers change, OEM fleet composition changes, privacy filters evolve thus making it harder to consistently compare resulting aggregate metrics such as VMT over a longer period of time especially with limited transparency on privacy filtering techniques adopted across the industry. However, the techniques defined in this report define a framework that OEMs could quite easily use to compute those metrics. Ultimately, market forces and regulatory decisions will shape how close to the vehicle or OEM those metrics are calculated.

5.2 Longitudinal Monitoring of Fast-Charging Deserts

Publicly available fast-charging station locations data from the Alternative Fuels Data Center (n.d.) enables stakeholders to longitudinally monitor the growth of charging infrastructure in their jurisdictions. By combining these station locations with available route network data, gaps in charging availability along AFCs can be easily determined as illustrated by the methodology in Section 4.6.

5.2.1 Indiana

Figure 5.3 shows a daily cumulative count of public DC fast-charging stations in Indiana for the past 13 years colorized by the provider network they belong to. The number of stations has risen consistently to about 189 as of the end of October 2025 with 13 different network providers accounting for that total.

Figure 5.4 builds on the methodologies described earlier and shows a summary overview of fast-charging deserts on

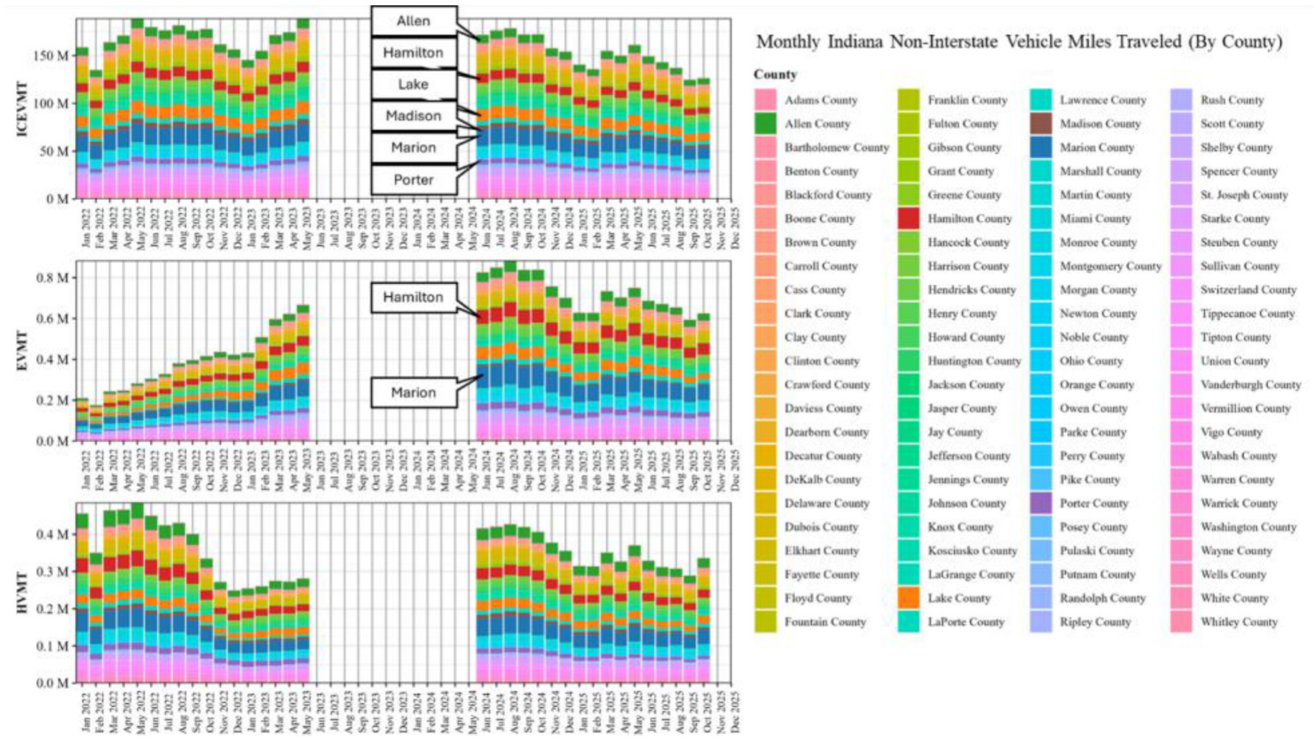


Figure 5.2 Indiana Non-Interstate VMT (January 2022–October 2025).

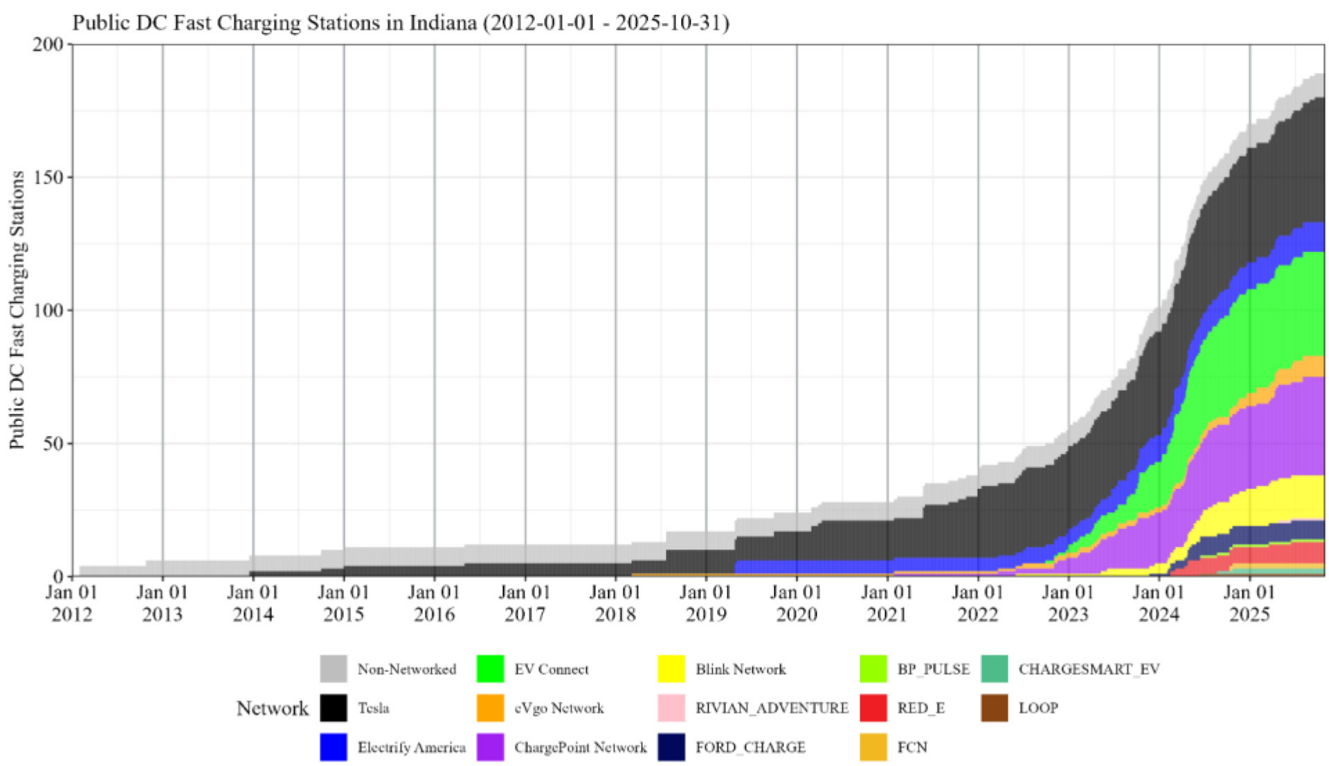


Figure 5.3 Public DC Fast Stations in Indiana (2012–2025).

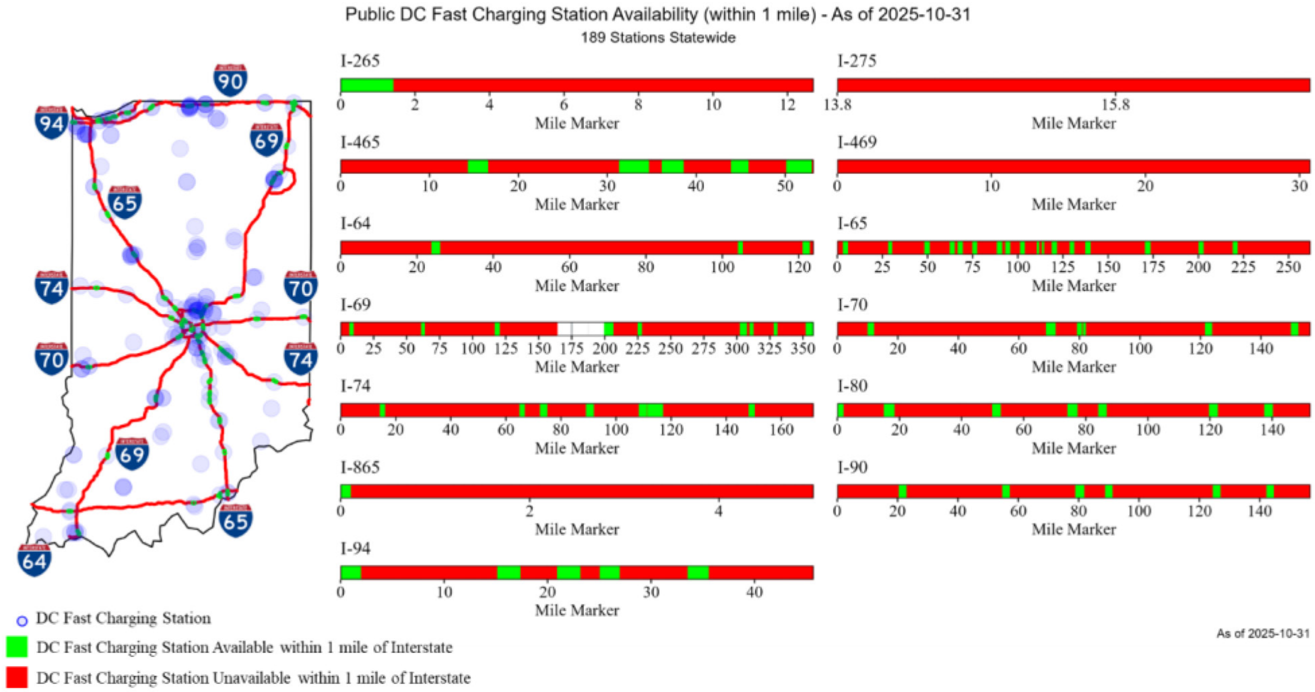


Figure 5.4 Indiana Interstate AFCs DC Fast-Charging Deserts (As of October 31, 2025).

TABLE 5.1
Longest Fast-Charging Deserts on Indiana Interstates.

Interstate Route	Longest Charging Desert (miles) As of October 31, 2025
I-265	11.20
I-275	3.30
I-465	14.80
I-469	30.60
I-64	78.30
I-65	40.60
I-69	75.10
I-70	57.20
I-74	49.20
I-80	33.30
I-865	4.80
I-90	33.60
I-94	13.20

Indiana's interstate system as of October 31, 2025. Table 5.1 provides a summary of the longest deserts observed on each interstate route. These lengths have evolved over the past several years and have significantly reduced as more and more fast-charging stations have become operational. It is encouraging to see that only three of the longest deserts are 50 mi or more in length.

Additionally, this reporting practice is not solely limited to interstates and can easily be extended to any route provided reliable linework and linear referencing are available. Figure 5.5 illustrates this scalability by presenting a charging desert visual for the remaining Indiana AFCs (US and State Routes).

5.2.2 Cross Border Scalability

These graphics scale well even across state borders as depicted by the three-state (Illinois, Indiana, Ohio) and six-route (I-64, I-70, I-74, I-80, I-90, I-94) visualization in Figure 5.6. This is especially important as states look to coordinate together to optimize charging infrastructure placements at state borders along priority corridors/AFCs. On Interstate I-64, for example, it is observed that there is a fast-charging station within a mile of the route in Illinois around MM 75 and the next such section is approximately 75 mi downstream in Indiana at MM 25. These reporting visuals serve well to provide an at-a-glance view of charging deserts on a route network.

6. CONCLUSION

This study utilized CV data to develop a number of methodologies and reporting procedures that document usage of transportation and charging infrastructure by EVs, along with a methodology to track fast-charging deserts along AFCs. While the market penetration of EVs is currently still low, the methodologies developed as part of this study present a framework for future long-term longitudinal monitoring of EV usage as CV data penetration continues to grow. The study team recommends two main outputs, namely VMT and fast-charging deserts, that can be longitudinally

Figure 5.5 Indiana US and State Route AFCs DC Fast-Charging Deserts (As of October 31, 2025).

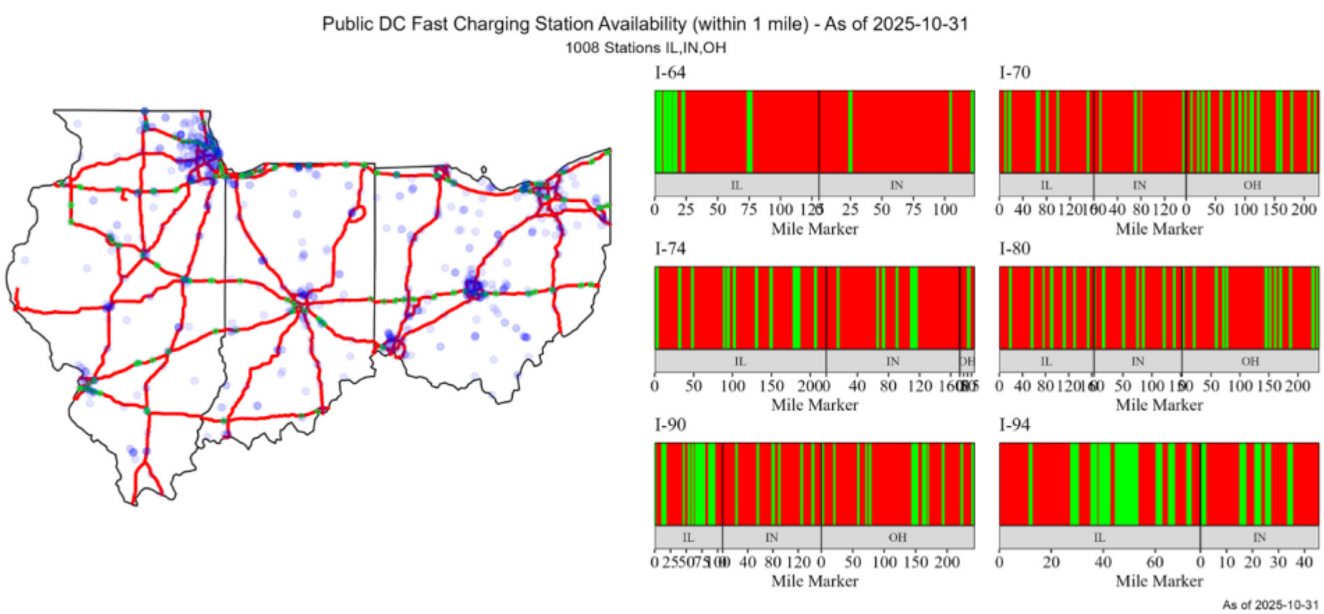


Figure 5.6 Illinois, Indiana, and Ohio Interstate Fast-Charging Deserts (As of October 31, 2025).

monitored over time and together present a good overview of EV usage in the state and whether public fast-charging infrastructure is keeping pace with evolving trends in EV use.

Furthermore, the following key findings and limitations emerged as a result of this study:

- Traditional count stations capture traffic volume but provide no data that captures EV travel patterns.
- Bureau of Motor Vehicle data provide little visibility on where EV trips occur.
- Furthermore, no data on EV trip lengths or EV travel in the state from vehicles registered out of the state are available.
- EV station locations are readily available. However, EV station charging session data have been difficult to obtain from the private sector, and it is unclear if any legislative or policy requirements are needed for this to occur.

- Charging deserts have been successfully monitored with a combination of public data and linear referenced routes prepared by this study.
- VMT, as well as trips for EVs, were obtained using CV data; however, evolving privacy challenges and changing filtering procedures in this space may reduce the viability of these data.
- Charge status is monitored by EV OEMs, but it is unlikely that they will want to share this data at scale.

7. FUTURE RESEARCH

This study's findings demonstrate the applicability of CV data towards prioritizing electric vehicle related charging infrastructure decision-making. Future research should look to leverage additional data sources including charging session data from operators, EV registrations data from the state, and charge status data from OEMs to provide a more holistic overview of EV and infrastructure usage.

The findings from this study may serve to initiate dialogue among the various private- and public-sector stakeholders to develop a shared vision on VMT-oriented performance measures that ensure user privacy and provide the necessary data for both public agencies and the private-sector stakeholders for making informed decisions on charging infrastructure deployment.

Additionally, the framework presented by this study may be utilized by state agencies to perform before-after analyses to determine the impact of NEVI program funding on the state of EV travel on their transportation infrastructure.

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APPENDICES

Appendix A. List of Acronyms

Appendix A. List of Acronyms

AFC	Alternative Fuel Corridor
CV	Connected Vehicle
DOT	Department of Transportation
EV	Electric Vehicle
EVMT	Electric Vehicle Miles Traveled
FHWA	Federal Highway Administration
HVMT	Hybrid Vehicle Miles Traveled
ICEVMT	Internal Combustion Engine Vehicle Miles Traveled
INDOT	Indiana Department of Transportation
MM	Mile Marker
NEVI	National Electric Vehicle Infrastructure
OEM	Original Equipment Manufacturer
SAC	Study Advisory Committee
VMT	Vehicle Miles Traveled

About the Joint Transportation Research Program (JTRP)

On March 11, 1937, the Indiana Legislature passed an act which authorized the Indiana State Highway Commission to cooperate with and assist Purdue University in developing the best methods of improving and maintaining the highways of the state and the respective counties thereof. That collaborative effort was called the Joint Highway Research Project (JHRP). In 1997 the collaborative venture was renamed as the Joint Transportation Research Program (JTRP) to reflect the state and national efforts to integrate the management and operation of various transportation modes.

The first studies of JHRP were concerned with Test Road No. 1—evaluation of the weathering characteristics of stabilized materials. After World War II, the JHRP program grew substantially and was regularly producing technical reports. Over 1,600 technical reports are now available, published as part of the JHRP and subsequently JTRP collaborative venture between Purdue University and what is now the Indiana Department of Transportation.

Free online access to all reports is provided through a unique collaboration between JTRP and Purdue Libraries. These are available at docs.lib.purdue.edu/jtrp/.

Further information about JTRP and its current research program is available at engineering.purdue.edu/JTRP.

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