Analyzing Electric Vehicle Charging Infrastructure Accessibility in Los Angeles, California

Vivian Sultan
California State University
Los Angeles, CA USA
email: vsultan3@calstatela.edu

Oscar Aguillon
California State University
Los Angeles, CA USA
email: oaguillon@calstatela.edu

***Abstract*—This project evaluates the distribution and accessibility of electric vehicle (EV) charging stations in Los Angeles, California, using a variety of geospatial analysis tools. As electric vehicles have become more popular, an accessible charging infrastructure will crucially support and encourage future growth. By performing service-area and closest-facility analyses, this study identifies key areas where EV charging stations are accessible and highlights regions still needing development. The findings emphasize the importance of strategic planning in EV infrastructure to enhance accessibility and promote wider adoption. This research provides insights for urban planners and policymakers to address gaps in the current infrastructure and propose new strategies for future development and demonstrates an analysis model applicable to other areas.**

Keywords—LiDAR; deep learning; point cloud; ArcGIS Pro; point classification.

I. INTRODUCTION

The growing adoption of electric vehicles (EVs) marks a big shift in the automotive industry, led by environmental concerns and technological advances. To accommodate the increasing number of EVs on the road, an accessible charging infrastructure must be developed. The Los Angeles region, known for its high population density and large urban landscape, presents both challenges and opportunities for implementing an EV-charging infrastructure.

California leads the nation in EV adoption rates and demonstrates a strong commitment to reducing greenhouse gas emissions and promoting sustainable transportation solutions. However, achieving these goals requires more than just increasing the number of electric vehicles; a network of easily accessible charging stations for all users, regardless of their location within the city, is crucial.

This project evaluates the current distribution and accessibility of EV charging stations in the Los Angeles area using ArcGIS Pro's geospatial analysis tools. Using the service-area and closest-facility analyses, this study aims to identify areas well served by existing EV charging station infrastructure and those that are underserved and require further development.

Understanding the current spatial distribution of charging stations enables urban planners and policymakers to improve the EV charging network based on real data. An effective charging infrastructure can reduce the range anxiety common among potential EV buyers, encouraging wider adoption and helping the state achieve its environmental goals. Furthermore, insights gained from these analyses can inform future planning efforts, ensuring that investments in EV infrastructure are well targeted and effective in the long run.

This research aims to provide valuable insights into Los Angeles' current EV charging infrastructure, highlight areas for improvement and offering recommendations for future development based on real data. This study's findings will contribute to ongoing sustainable-transportation discussions and EVs' specific role in achieving these targets.

The rest of this report is structured as follows. Section 2 reviews the relevant literature. Section 3 details the methods used. Section 4 outlines the results. Section 5 discusses the findings and their implications. Section 6 concludes.

II. LITERATURE REVIEW

Cui et al. [1] focused on methods for strategically placing EV-charging stations in urban areas, highlighting the importance of considering power-flow constraints and protection-device upgrades to avoid costly future upgrades and ensure efficient power distribution. This analysis helped understand the complexities of charging-station placement and clarified the research goals.

Wen et al. [2] examined global trends and challenges in EV-charging-infrastructure deployment and emphasized the need for strategic planning and energy management to meet increasing EV demand, categorizing different planning models for various regions. This study gave a global perspective on EV infrastructure and its potential benefits for sustainability and grid-strain reduction, helping me understand the research on Los Angeles and such key factors as grid strain.

Furthermore, Azadfar et al. [3] determined optimal EV-charging-station placement using advanced algorithms and models, considering such factors as traffic flow and user convenience. This study gave me insights into advanced analytic techniques for optimal EV charging station placement, helping inform the ArcGIS spatial analysis.

The methodology of Sultan et al. [4], which used geographic information system (GIS) tools to identify gaps in the EV-charging infrastructure, was extremely useful for understanding current infrastructure assessments. Their approach highlighted the need for more stations, but did not incorporate dynamic factors like traffic patterns, inspiring me to explore that avenue myself. We expanded our analysis to include real-time data, aiming to provide a more detailed picture of accessibility and distribution. By incorporating live-traffic impacts on charging-station accessibility, this report builds on this foundation and methodology.

Overall, these studies provided a comprehensive understanding of the EV-charging-infrastructure landscape, highlighting challenges, opportunities, and recommendations. They guided research question formulation and methodology, ensuring the analysis was informed in existing literature while adding meaningful data like live traffic patterns to distinguish the research.

III. METHODOLOGY

This study used a geospatial analysis methodology through ArcGIS Pro to evaluate the current distribution and accessibility of EV charging stations in the Los Angeles region (Figure 1). This approach involved several key components, each designed to assess the current infrastructure and identify areas for potential improvement.

The first phase of the methodology involved initial data collection, which focused on gathering and importing datasets on EV-charging-station locations, road networks—including primary and secondary roads—and demographic characteristics of the region, including live traffic data (Figure 2). The data was sourced from the ArcGIS Living Atlas, ensuring a reliable dataset and an easy framework to import into ArcGIS Pro.

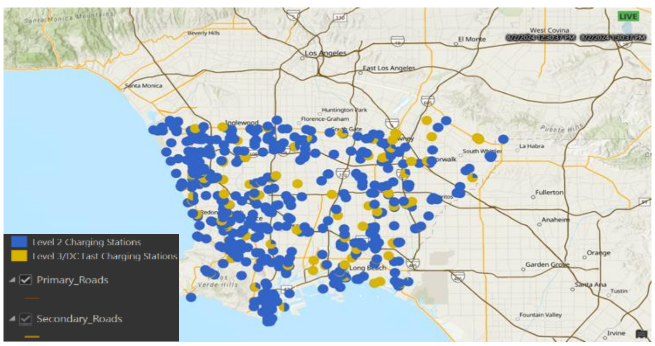


Figure 1. Geographic Scope of the Study Area: Los Angeles Region.

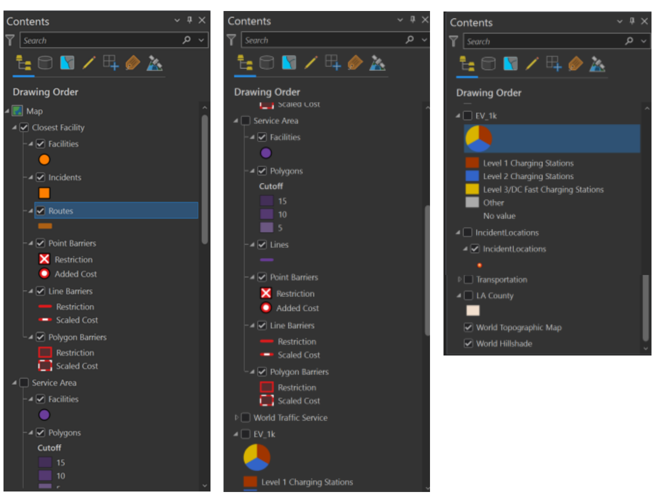


Figure 2. Data Sources and Layers Used in the Analysis.

With the data successfully imported, the second phase centered around using ArcGIS Pro's advanced geospatial tools. Specifically, this project used the Service Area Analysis and Closest Facility Analysis Network Analyst tools. These tools played an integral role in mapping the accessibility and distribution of charging stations. The Service Area Analysis tool was employed to create polygons representing areas within a certain travel time from each charging station. This step was crucial to understanding the reach of each station and highlighting underserved areas that fell outside typical driving distances. It visually identified potential gaps in the infrastructure.

Additionally, we used the Closest Facility Analysis tool to determine the nearest charging station to selected incident points. These points represented such key locations as major transportation hubs, educational institutions, residential areas, and major traffic intersections, providing insights into the practical day-to-day accessibility of charging stations from these locations throughout the region.

An important aspect of the methodology was integrating real-time traffic data into the analysis. Analyzing changing travel conditions enhanced the accessibility assessments, offering a more realistic view of how traffic patterns impact charging stations' accessibility.

The final phase of the methodology involved visualizing and interpreting the results. Thematic maps visually represent the distribution and accessibility of charging stations. These maps facilitated the identification of areas well served by the current EV infrastructure and those requiring further development.

Overall, the various phases of the methodology process for this project facilitated a detailed evaluation of the current EV charging infrastructure in the Los Angeles region. The insights gained from this analysis can help urban planners and policymakers make data-driven decisions to enhance the accessibility of charging stations and ultimately promote wider adoption of electric vehicles.

IV. RESULTS

The analysis of service areas around each EV charging station was organized into three main categories based on travel time: 5 minutes, 10 minutes, and 15 minutes (Figure 3). Each category was visually represented using specific shades of purple, with lighter shades depicting shorter travel times. The 5-minute areas, depicted in light purple, are the most densely covered and indicate regions where an EV charging station is highly accessible. Residents and commuters in these areas can conveniently reach a charging station within a 5-minute drive, ensuring that EV users have easy access to charging facilities for their vehicles.

The 10-minute areas, represented in medium purple, serve as transitional areas with moderate coverage. While they suggest a reasonable level of accessibility, these areas might be at the edge of convenience for those needing quick charges. Residents in these areas may experience slightly longer travel times to access charging stations, which could impact the decision-making of potential EV buyers.

The 15-minute areas, shown in dark purple, indicate zones where accessibility drops significantly. These regions could be considered underserved in terms of rapid access to EV charging facilities, challenging current and potential EV owners. The limited accessibility in these areas suggests a need for expansion of the charging network to better serve the population and encourage broader adoption of electric vehicles.

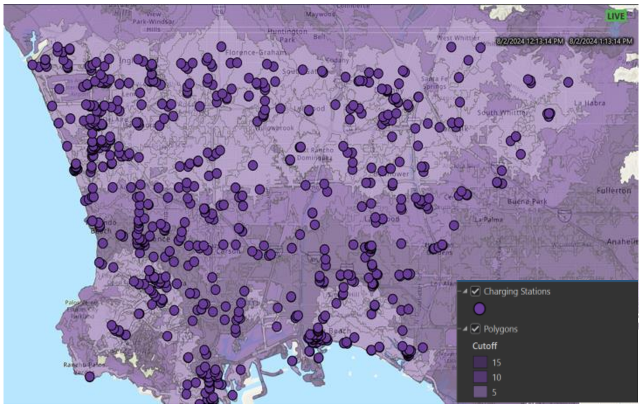


Figure 3. Service-Area Analysis: Travel Times to EV Charging Stations.

The implications of these accessibility levels are significant. The lighter shaded areas, predominantly centered around major urban and commercial hubs, reflect solid infrastructure catering to a high density of EV users. In contrast, the darker shades, particularly found in the outskirts and less urbanized areas, highlight the need for expansion of the charging network. Addressing these underserved areas is crucial to support both potential and existing EV owners and to encourage further growth in EV adoption.

Integrating real-time traffic data provided a dynamic overlay to the service-area polygons (Figure 4). This inclusion offered insights into how regular traffic conditions affect accessibility to charging stations during different times of the day or week. By considering traffic patterns, the analysis goes beyond just geographical proximity, providing a more detailed understanding of accessibility challenges that EV users might face in their daily commutes or travel routines.

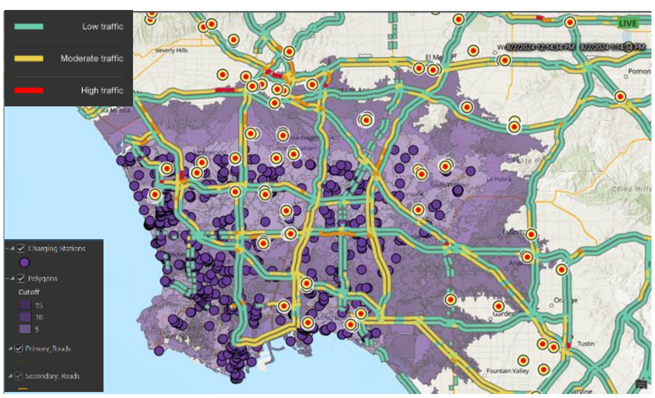
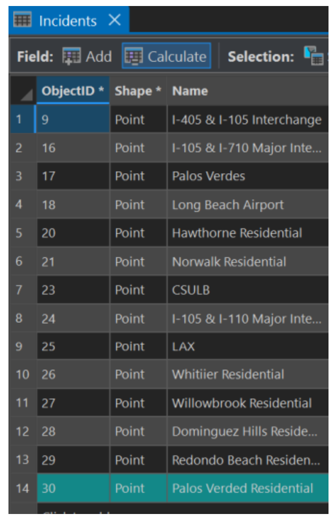


Figure 4. Service-Area Analysis: Travel Times to EV Charging Stations with Live Traffic.

Thematic maps generated from the analysis visually show the service coverage. These maps are instrumental in identifying specific areas where policy interventions, infrastructure enhancements, and targeted investments could significantly improve service reach and, consequently, EV adoption rates. By identifying gaps in coverage, stakeholders can make informed decisions to strategically enhance the EV charging infrastructure, ultimately supporting the transition to more sustainable transportation options.

We conducted the closest-facility analysis to evaluate the accessibility of EV charging stations from specific incident points within both urban and suburban regions (Figure 5). These points are depicted as orange squares on the map, highlighting the proximity to nearby charging stations. This analysis was crucial in determining which areas have sufficient coverage and which require infrastructure improvements. Most designated points, including major transportation hubs like Los Angeles and Long Beach airports, as well as educational institutions such as Cal State Long Beach, are conveniently located within a 5-minute drive from a charging station, demonstrating the great accessibility within the existing EV network.



Incidents

Field: Add Calculate Selection:

	ObjectID *	Shape *	Name
1	9	Point	I-405 & I-105 Interchange
2	16	Point	I-105 & I-710 Major Inte...
3	17	Point	Palos Verdes
4	18	Point	Long Beach Airport
5	20	Point	Hawthorne Residential
6	21	Point	Norwalk Residential
7	23	Point	CSULB
8	24	Point	I-105 & I-110 Major Inte...
9	25	Point	LAX
10	26	Point	Whitiier Residential
11	27	Point	Willowbrook Residential
12	28	Point	Dominguez Hills Reside...
13	29	Point	Redondo Beach Residen...
14	30	Point	Palos Verded Residential

Figure 5. Incident Points: Closest-Facility Analysis.

However, certain residential areas like Whittier, Palos Verdes, and Dominguez Hills displayed significant gaps, with no stations within a 5-minute radius (Figures 6 and 7). Particularly in Palos Verdes, disparities in access were evident even within the same city, as one incident point within the city had a charging station within 5 minutes, while another did not. This difference within the same city demonstrates the accessibility challenges EV users might face due to lacking infrastructure. Enhancing the infrastructure in these areas could greatly improve the viability and appeal of EV ownership, potentially fostering wider adoption.

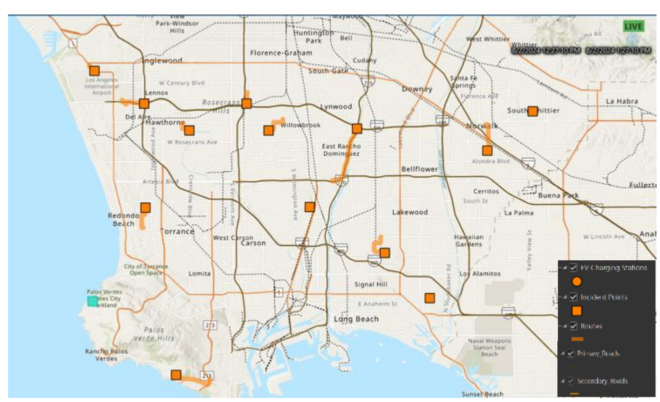


Figure 6. Closest-Facility Analysis from Key Incident Points.

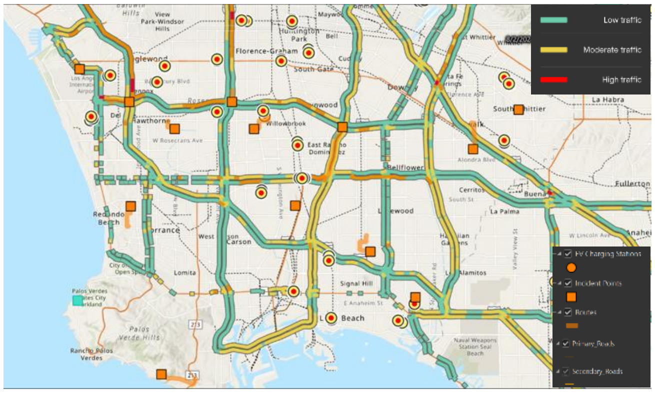


Figure 7. Closest-Facility Analysis with Live Traffic Data Layer Overlay.

The findings from this analysis are crucial for urban planners and stakeholders, indicating a clear need for more equitable charging-station access across all regions to support and encourage the adoption of electric vehicles.

V. Discussion

The geospatial analysis conducted in this study demonstrates the disparities in the accessibility of EV charging stations across the Los Angeles region. The results highlight a need for strategic planning and expansion of the EV infrastructure to support the growing demand for electric vehicles. Specifically, the service area analysis revealed that while major urban centers and commercial hubs have an accessible EV-charging infrastructure, suburban and less urbanized regions face accessibility challenges. This imbalance aligns with previous studies [4], which identified gaps in the EV charging infrastructure and discussed the importance of comprehensive planning to address this. The visual representation through the service-area-analysis tool helped highlight underserved areas, particularly those with 15-minute or greater travel times to the nearest charging station, indicating a pressing need for targeted infrastructure development based on real data.

Using real-time traffic data in the analysis, this study provided a deeper understanding of accessibility challenges than static geographical analysis alone. Incorporating the dynamic nature of traffic conditions allows us to evaluate the practical challenges of reaching charging stations, with traffic being a well-known barrier. Considering such factors in infrastructure planning is crucial as it highlights all the complex elements involved in this type of infrastructure. This approach builds upon the methodology suggested by Azadfar et al. [3], who advocated for incorporating traffic flow and user convenience in determining charging-station placement.

This study's findings have significant implications for urban planners and policymakers. The accessibility gaps identified in areas like Whittier, Palos Verdes, and Dominguez Hills suggest a need for equitable access to EV charging facilities. By addressing these gaps, urban planners and policymakers can potentially reduce the range anxiety among potential EV users and help encourage broader adoption of electric vehicles. The strategic placement of new charging stations in these underserved areas will enhance accessibility, reduce travel times, and align with the planning models discussed by Wen et al. [2]. Additionally, considering the environmental and sustainability goals of the Los Angeles region, a pioneer in EV infrastructure, these recommendations can significantly contribute to expanding the EV charging network, thereby reducing greenhouse gas emissions and promoting cleaner transportation alternatives.

To promote wider EV adoption and support the transition to more sustainable transportation, this study recommends expanding the charging infrastructure by targeting areas identified as underserved, particularly those with limited access within a 15-minute travel time, and prioritizing these locations for new charging-station installations. This study also suggests engaging stakeholders by collaborating with local governments and utility companies to develop a plan for EV-infrastructure expansion that reflects the needs and inputs of these various entities, including stakeholders and investors, to ensure the effective expansion of EV infrastructure.

VI. Conclusion

This study has provided an in-depth analysis of the accessibility and distribution of EV charging stations in the Los Angeles region, focusing on key areas that require attention and development. Geospatial analysis tools such as service area analysis and closest facility analysis within ArcGIS Pro identified significant gaps in the current EV infrastructure, particularly in suburban and less urbanized areas. The integration of real-time traffic data into the analysis highlighted the importance of considering dynamic factors when planning for infrastructure development.

This research supports the need for strategic planning and investment to enhance the accessibility of EV charging stations, which will ultimately support the broader adoption of electric vehicles. As California continues to lead the nation in EV adoption, the infrastructure must keep pace with demand to ensure a successful transition. This study's recommendations offer a promising roadmap for urban planners, policymakers, and stakeholders to develop a more equitable and efficient EV charging network. By prioritizing underserved areas and engaging in open discussions with local governments, utility companies, and other stakeholders, Los Angeles can set an example for other regions striving to enhance and develop their EV infrastructure. It is all about planning strategically and using real-world data to inform decisions.

In conclusion, this research provides valuable insights into the current state of Los Angeles' EV-charging infrastructure, as well as practical solutions for its improvement. Real-time data and advanced geospatial analysis can inform decisions to align with the evolving needs of the community and contribute to the broader goal of sustainable urban transportation. Collaboration between public and private entities will be crucial to achieving these objectives and ensuring that Los Angeles continues to lead the EV revolution.

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