Title

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eTranSym: A Tool for Gap Assessment and Demand Profile Projection of Public Charging Infrastructure in Electrified Transportation Systems

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Issue

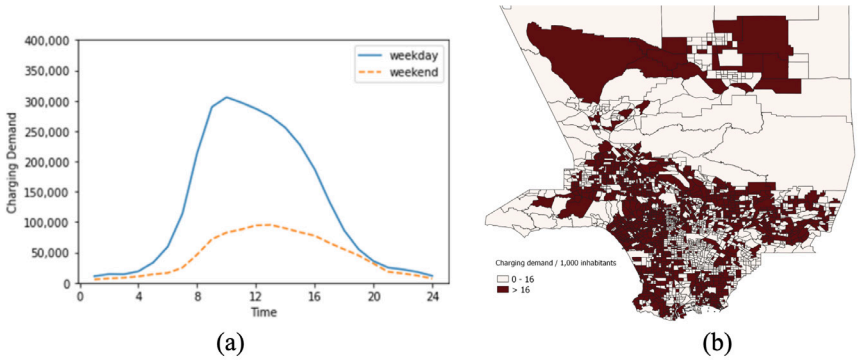
Transportation systems are undergoing a fundamental transition toward electrification. The shift to electrification, characterized by the widespread adoption of electric vehicles (EVs), the expansion of charging infrastructure, and the integration of renewable energy sources, has the potential to yield significant societal benefits. These include climate change mitigation, alleviation of air pollution, and enhancements in overall human well-being. However, the existing infrastructure related to transportation electrification, particularly in the domain of public chargers, remains inadequate to support this sweeping transition. This insufficiency has led to inconvenient EV charging experiences, impeded the establishment of a comprehensive nationwide charger network, and resulted in disparities in charging accessibility across diverse communities.

To meet the increasing charging requirements of EVs and facilitate a seamless transition to electrified transportation, this study introduces a comprehensive analytical tool known as eTranSym. eTranSym is intended to address the following critical questions through its implementation in Los Angeles County:

1. How does the electrification process create public charging needs at the system and census tract levels?
2. How do variations in travel demand and network functional supply impact the projection of public charging needs?
3. How does the spatial-temporal distribution gap of charging infrastructure affect accessibility, especially in low-income and disadvantaged communities (DACs)?

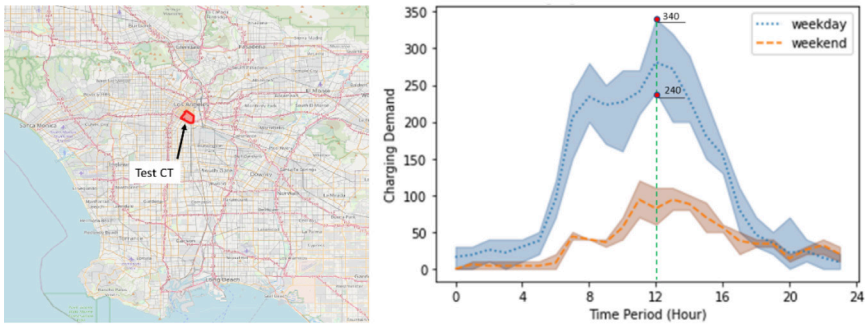
Key Research Findings

- In 2035, Los Angeles County is expected to have between 160,000 and 290,000 Level 2 chargers and 40,000 to 70,000 Level 3 chargers (also known as DC fast chargers), with installation costs ranging from $300 million to $600 million, based on the “moderate” and “high” electrification goals from the National Renewable Energy Laboratory.
- The average charging demand on weekdays is significantly higher than weekends across all time periods (Figure 1). This difference is primarily due to mandatory weekday trips for commuting to and from work or school. The peak of daily charging demand occurs around 10 a.m. to 11 a.m. on weekdays and 1 p.m. to 2 p.m. on weekends.
- The simulation results indicate that charging demand is sensitive to variations in both travel demand and supply. This fluctuation accounts for approximately 27% of the average charging need (Figure 2).
- The charging demand projection results reveal the need for denser public chargers among DACs, areas with high rates of Hispanic populations, and non-Hispanic whites. DACs and Hispanic residents require more chargers due to their low home and workplace charger density, while non-Hispanic whites need additional chargers because of their high EV adoption.



(a) (b)

Figure 1. The system-level public charging demand distribution in Los Angeles County in 2035: (a) temporal; (b) spatial.



(a) (b)

Figure 2. Temporal charging demand distribution of a test census tract (CT). a) The location of the test CT. b) 24-hour charging demand distribution of the test CT. The semi-transparent bands represent the upper and lower bound of the charging demand across multiple scenarios.

Conclusions and Recommendations

- The projected charging demand within the transportation system fluctuates due to variations in travel demand (e.g., across different days of the week) and travel supply (due to weather conditions, road incidents, and EV adoption rates).
- Charging demand has distinct peak hours for different functional areas: from 11 a.m. to 1 p.m. for work and school areas, and from 2 p.m. to 4 p.m. for shopping and dining areas. This suggests a strong correlation between public charging load and daily activity patterns.
- When accounting for variations in charging demand, the total installation cost of Level 2 and Level 3 DC fast chargers in Los Angeles County ranges from $272.8 million (for the "moderate" electrification goal) to $537.7 million (for the "high" electrification goal) under the 75% satisfaction level. The costs increase to $296.1 million and $599.6 million, respectively, under the 100% satisfaction level.
- To encourage EV usage and ensure the fair distribution of public chargers, equity improvements are suggested: 1) increase the accessibility of charging facilities by deploying sufficient public chargers in low-income areas; 2) enhance home and workplace charger adoption for DACs and Hispanic populations; 3) reduce public charging fees by using renewable energy specifically for low-income users, DACs, and communities of color.

More Information

This policy brief is drawn from the "eTranSym: A Tool for Gap Assessment and Demand Profile Projection of Public Charging Infrastructure in Electrified Transportation Systems" research project by the UCLA Institute of Transportation Studies. The full work can be found at https://www.its.ucla.edu/project/etransym. For more information about the findings in this brief, contact Jiaqi Ma at jiaqima@ucla.edu.

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