Moving Towards the Electrification of Medium- and Heavy-Duty Vehicles in the Inland Empire

Presented By

Bhavik Khatri

Background & Motivation

California's initiative to transition to zero-emission medium- and heavy-duty vehicles (MDHDVs) to combat climate change and reduce greenhouse gas emissions, with transportation being a major contributor.

The critical environmental situation in California's Inland Empire (IE), including high levels of ozone and particle pollution due to heavy MDHDV traffic and warehouse activities.

The complexity of electrifying MDHD fleets, considering their size, weight, and energy requirements, alongside the need for advanced battery technologies and charging infrastructure.

The societal and economic implications of the transition, highlighting the potential for reduced maintenance costs, longer vehicle lifespans, and concerns about social equity and workforce training.

Research Objective

- Investigate feasibility & impacts of zero-emission MDHDVs in IE, focusing on EV charging infrastructure & strategies.
- Tailor electrification strategies to IE's subregions, addressing social equity & economic viability.
- Assess regional policies, traffic patterns, infrastructure needs, expert perspectives, ensuring social equity & economic viability.

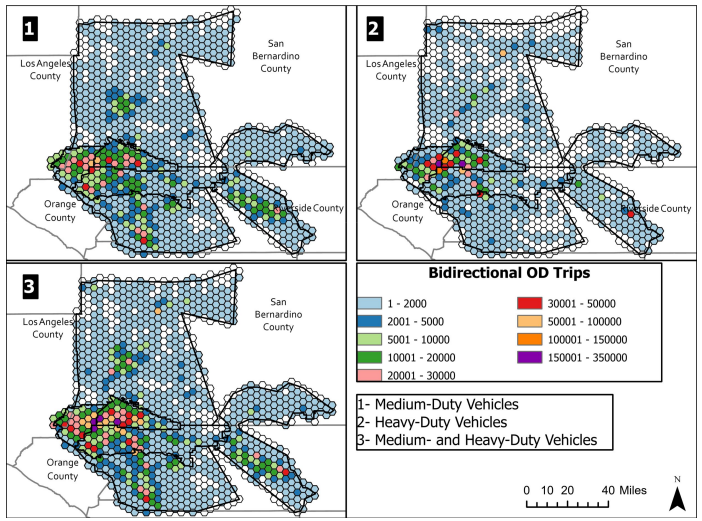
Literature Study

- Assess policies for ZEV transitions, considering social equity and small operators.
- Analyze advancements in battery tech and smart management systems for MDHDVs.
- Review studies on MDHD fleet electrification's environmental, economic benefits, and equity implications.

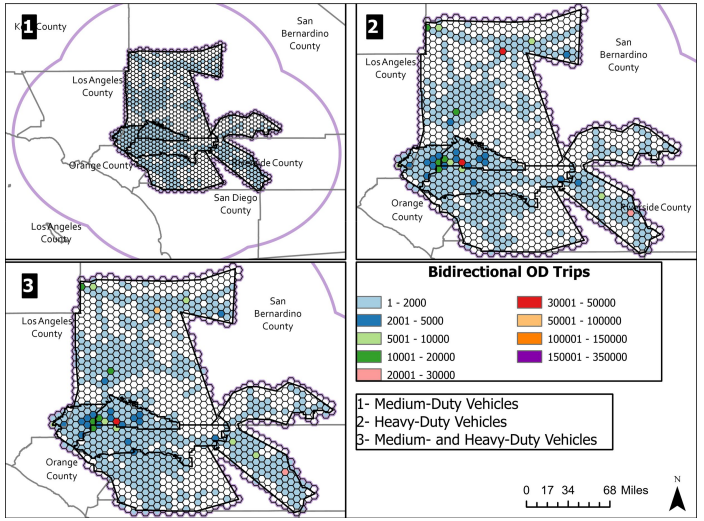
Methodology

- Utilize diverse methods: literature review, geospatial analysis, big data analytics, and expert interviews.
- Employ geospatial analysis for traffic patterns, infrastructure, and EV charging station locations.
- Leverage data analytics tools (StreetLight Data, CARB Fleet Database) and expert interviews for insights on vehicle movements and operational efficiencies.

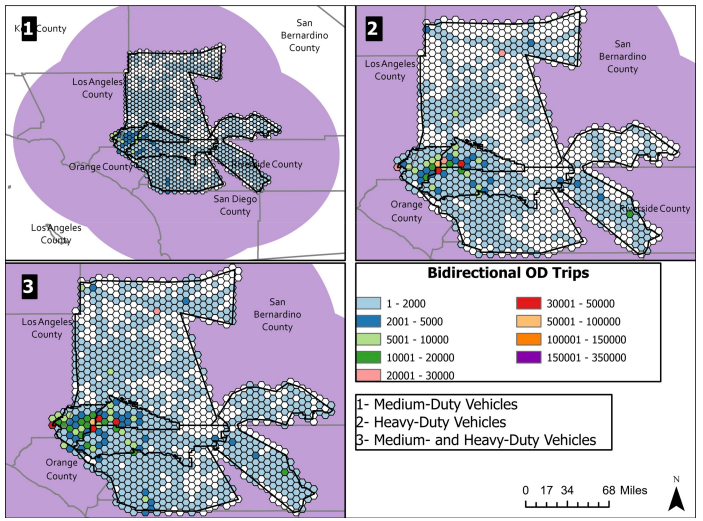
Results & Analysis



Bidirectional OD Trips within the Inland Empire



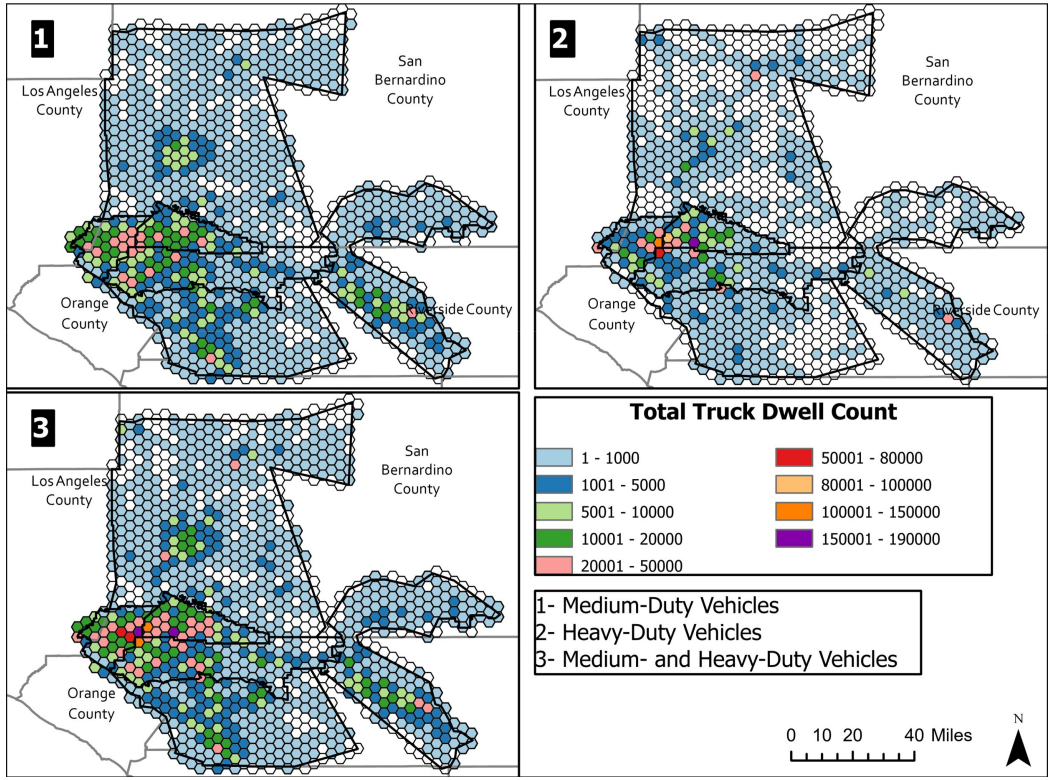
Trips Outside the Buffer to/from the Inland Empire



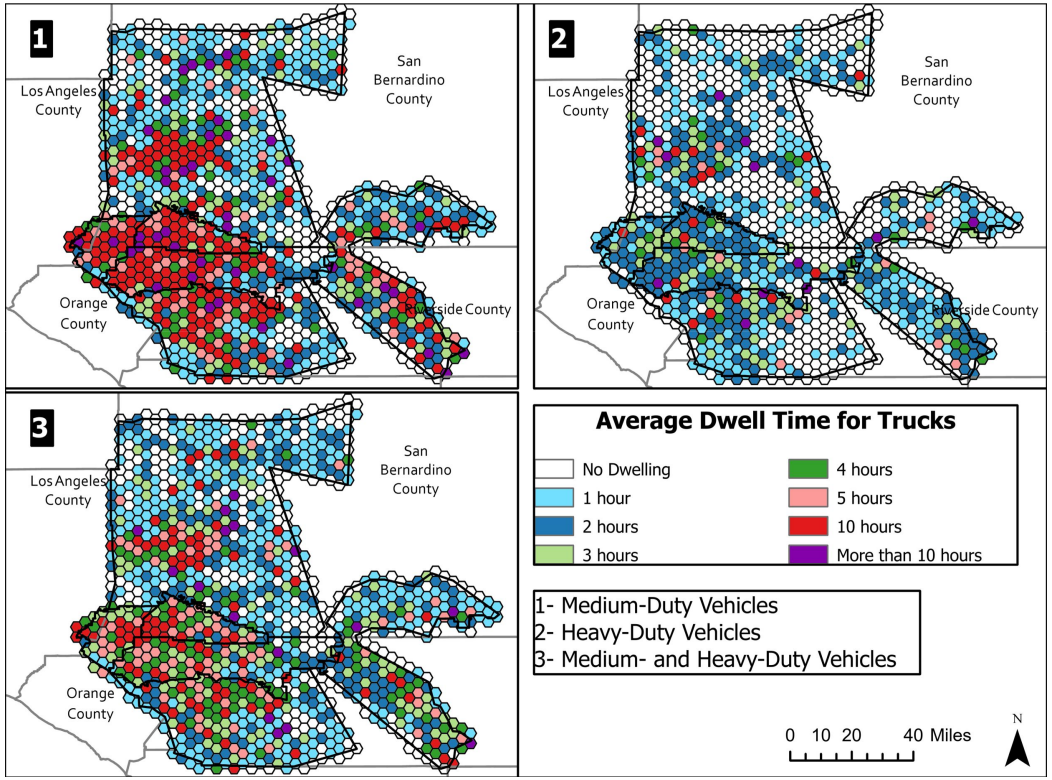
Bidirectional OD Trips between the Buffer Zone and the Inland Empire

- **Map 1** illustrates concentrated bidirectional **trips in W, NC, and SC areas, some exceeding 150,000 trips**, while HDV trips are mainly in W and NC subregions, with limited activity in the N subregion.
- **Map 2**, "Trips Outside the Buffer To and From the Inland Empire," highlights short-haul trips within Southern California, with peak MDV trips in the W, NC, and SC subregions, and Barstow in the **N subregion** showing notably high HDV traffic (up to **30,000 trips**).
- Map 3, "Bidirectional OD Trips between the Buffer Zone and the Inland Empire," reflects HDV traffic dominance in LH trips, while Map 2 highlights higher HDV traffic in NC and parts of the E subregion, with Barstow in the N subregion reaching up to 50,000 trips.

Results & Analysis



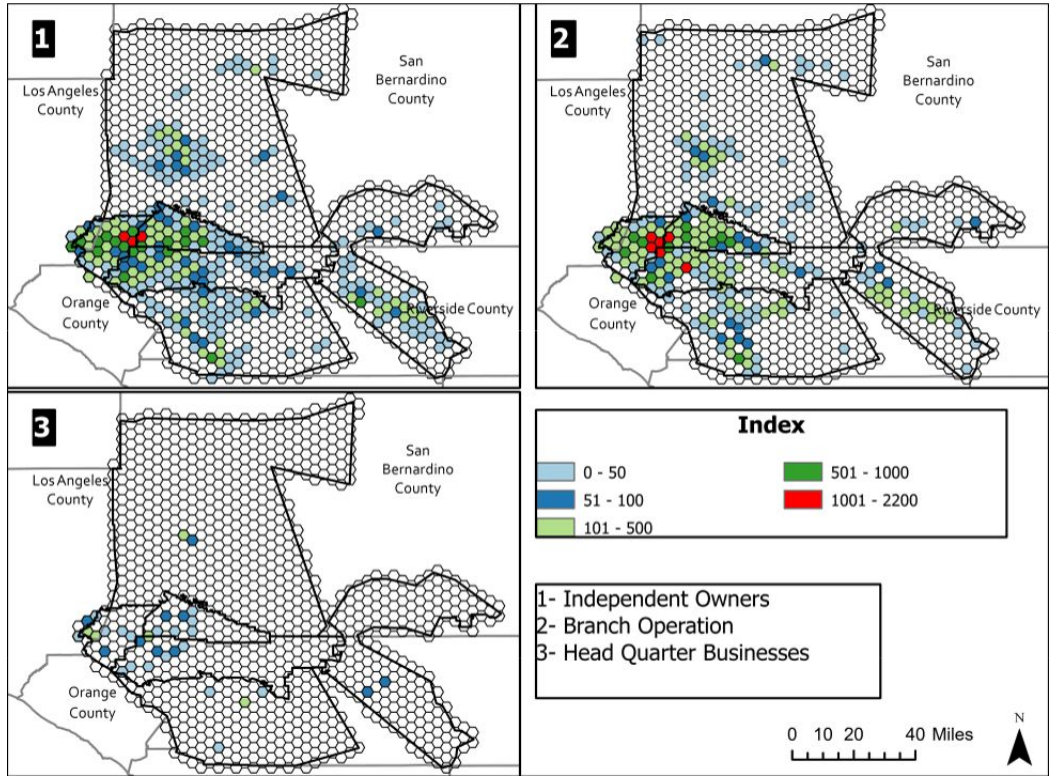
MDHDVs Dwell Count in the Inland Empire



MDHDVs Average Dwell Time in the Inland Empire

- Map 1: MDV and HDV peak counts in W and NC, with Barstow (N) recording 20,000+ HDVs. Highest MDHDV counts in NC and E, revealing distribution insights.
- Map 2: MDV dwell times average 10 hours in E, NC, SC, S; HDVs lower. Overall, dwell times exceed 3 hours in most regions when MDVs and HDVs are combined.
- Dwell time refers to the duration vehicles spend parked or idle at a location, providing insights into operational efficiency.

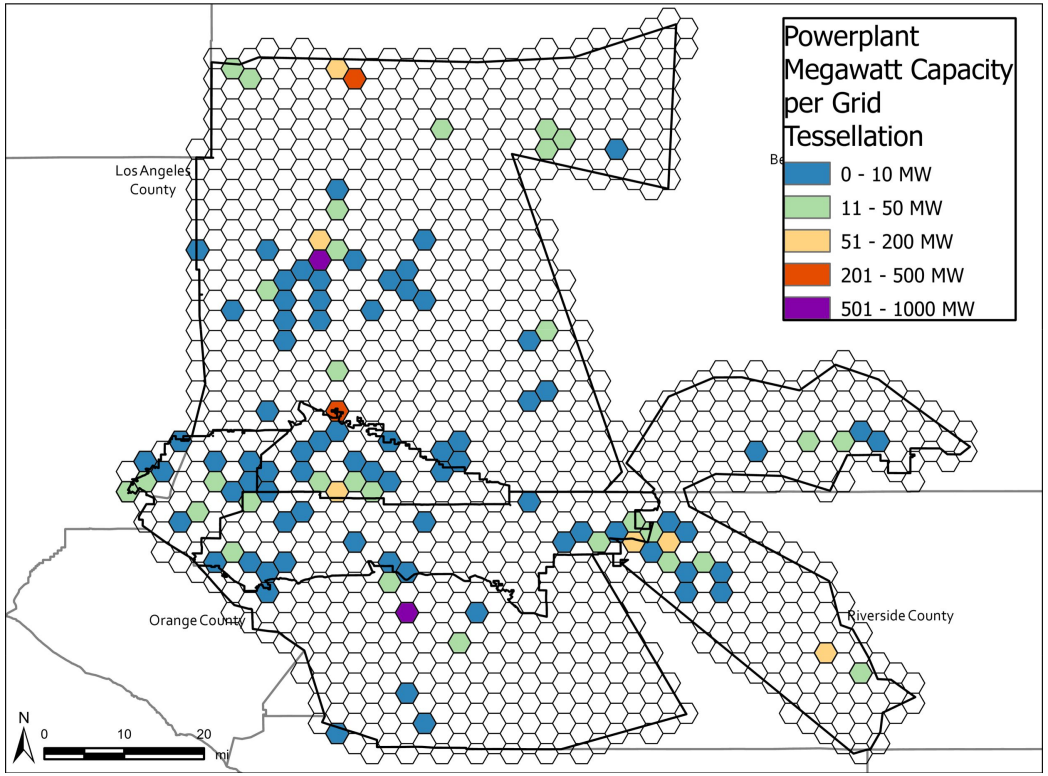
Results & Analysis



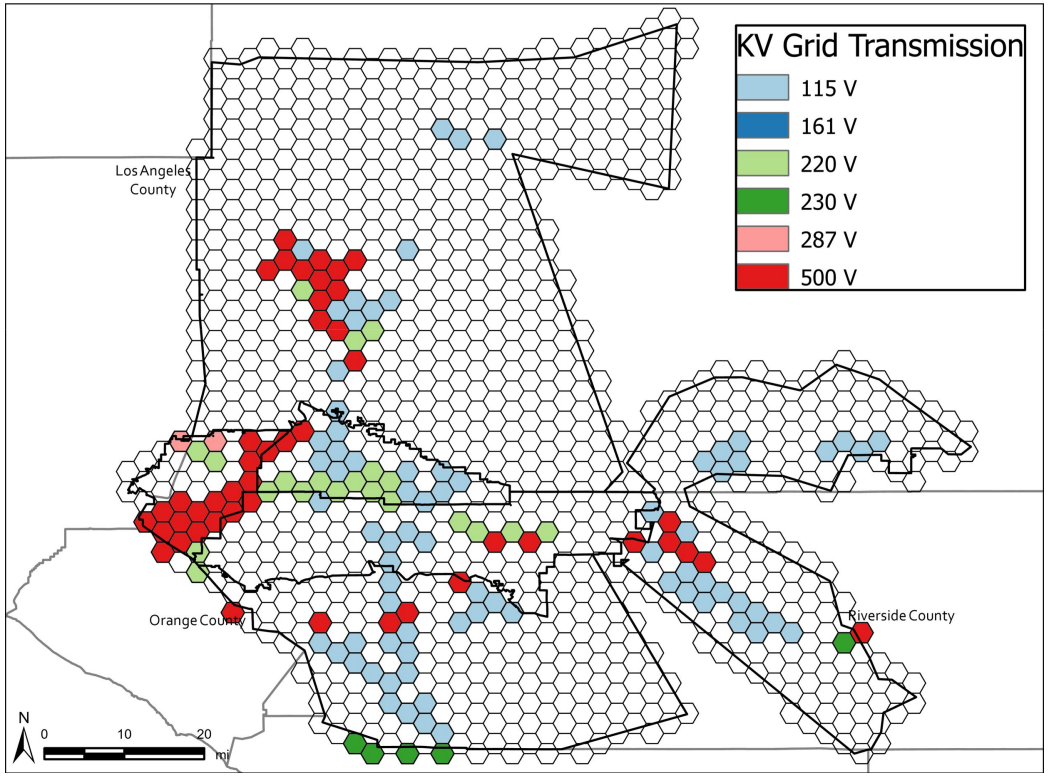
Index Reflecting the Independent Owners, Branch Operation and Head Quarter Businesses in the Inland Empire

- The "Index Reflecting the Independent Owners, Branch Operation and Headquarters Businesses in the Inland Empire" consists of three maps depicting business density across the IE.
- Map 1 emphasizes a concentration of independent owners in the E, NC, and SC subregions, with notable density in the N, E, and S.
- Map 2 mirrors this trend for branch operations, indicating similar patterns of density across regions.
- Map 3 reveals fewer headquarters businesses, providing insights into regional business distribution within the Inland Empire.

Results & Analysis



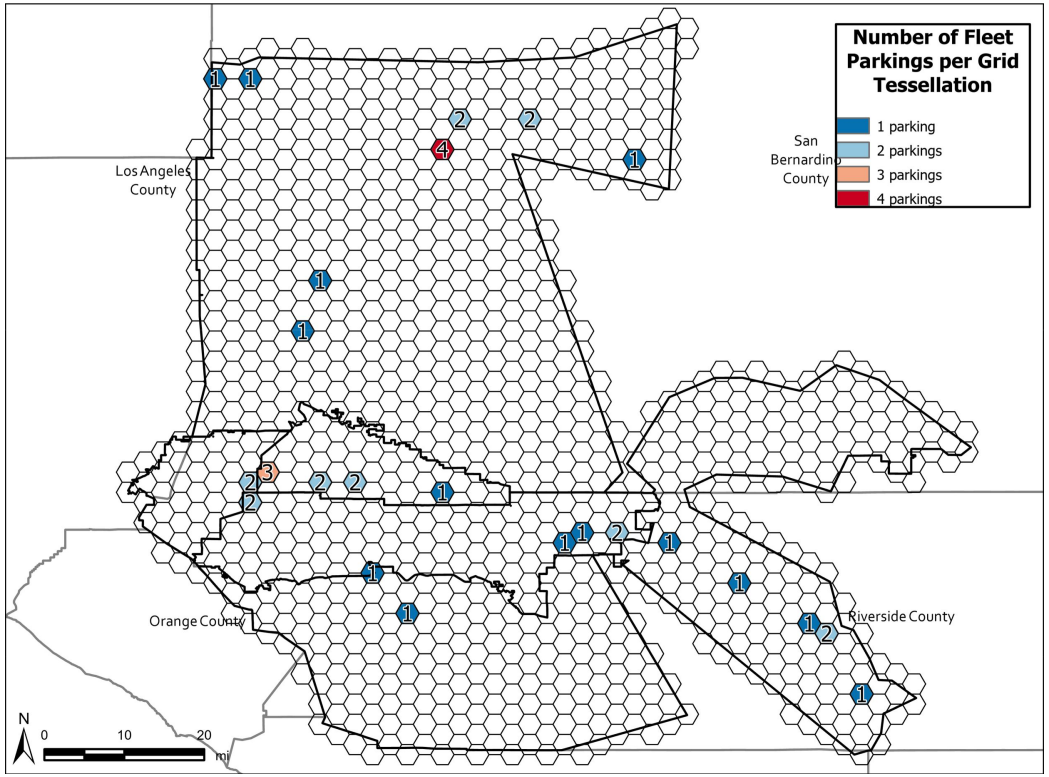
Total Megawatt Capacity Produced by Power Plants in the Inland Empire



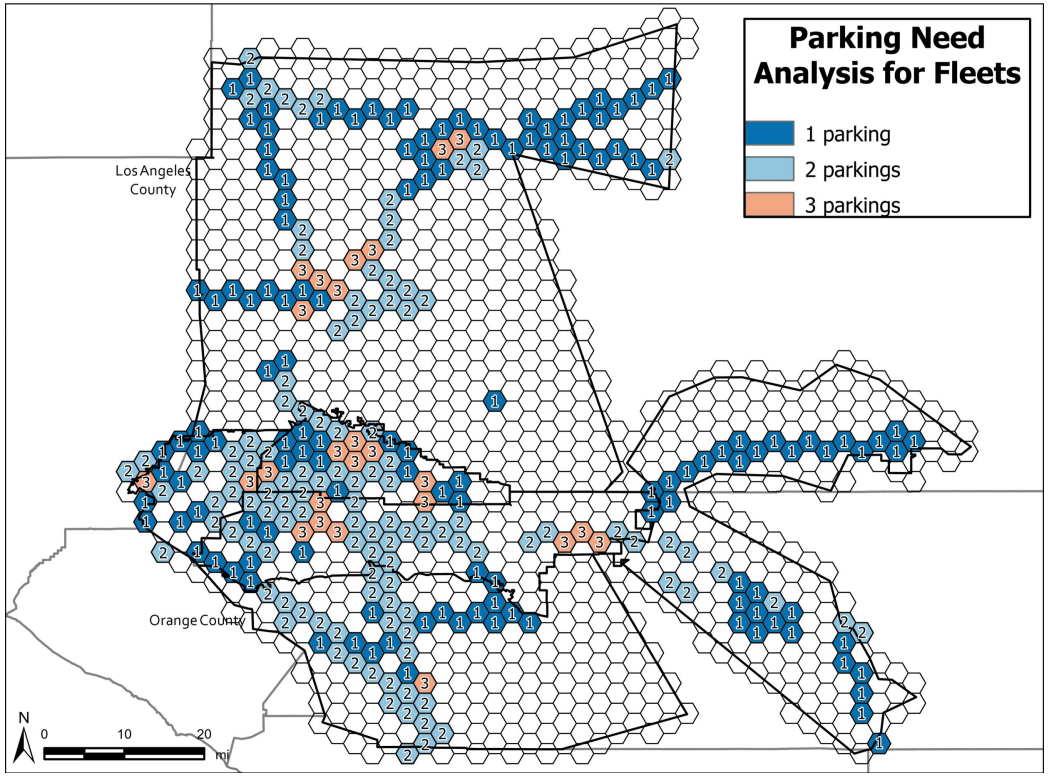
Grid Transmission Capacity (kV) Across the Inland Empire

- IE's power plant capacities, shown in MW output, range from 0-10 MW to 501-1000 MW. Higher-capacity plants, mainly in the 501-1000 MW range, are concentrated in the N subregion, with one in the S. Plants generating 0-200 MW are scattered across SC, NC, W, and E, with more in the W and NC.
- The visualization displays grid transmission capacities across subregions, with dark red hexagons (500 V) indicating high capacities primarily in the N and W. Isolated high-capacity hexagons are found in the E and S, while NC and SC show lower voltage levels, suggesting reduced capacities.

Results & Analysis



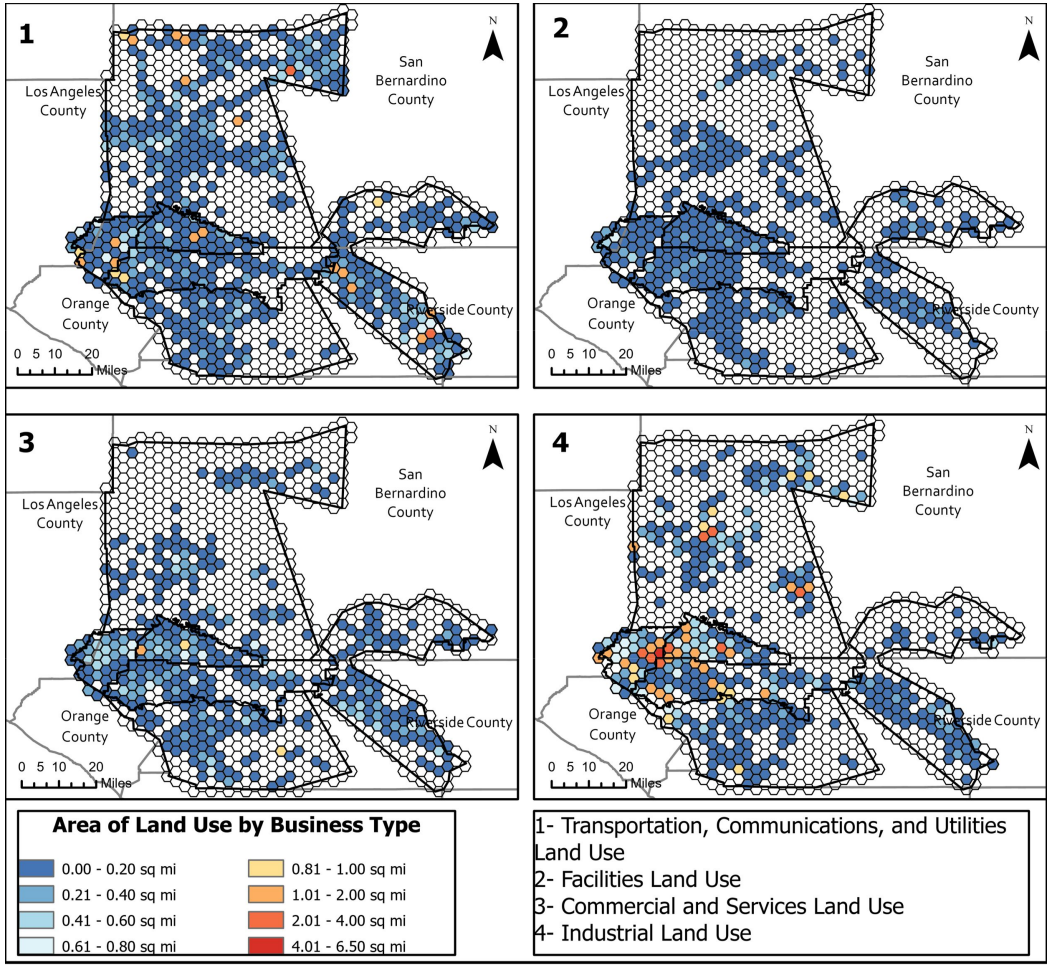
Fleet Parking Availability in the Inland Empire Region, 2021



Fleet Parking Need Analysis in the Inland Empire Region, 2021

- In Map 1, "Fleet Parking Availability," a hexagonal grid depicts parking availability in the IE. Colors indicate spots per cell: blue (1), light blue (2), orange (3), and red (4). Parking is dispersed, mainly single spots across all subregions, with a parking need analysis included (Caltrans, 2022).
- Map 2, "Fleet Parking Need Analysis," highlights parking demands in the Inland Empire Region, 2021. W, NC, and SC exhibit significant demand, particularly for 3 spots in NC and SC. The N subregion also shows substantial demand, while the S and E subregions require fewer spots.

Results & Analysis



Distribution of Business-Centric Land Use in the Inland Empire by Type and Total

- The "Index Reflecting the Independent Owners, Branch Operation and Headquarters Businesses in the Inland Empire" consists of three maps depicting business density across the IE.
- Map 1 emphasizes a concentration of independent owners in the E, NC, and SC subregions, with notable density in the N, E, and S.
- Map 2 mirrors this trend for branch operations, indicating similar patterns of density across regions.
- Map 3 reveals fewer headquarters businesses, providing insights into regional business distribution within the Inland Empire.

Conclusion

- In-depth analysis conducted on transportation and urban systems within the Inland Empire, providing a thorough understanding of the region's dynamics.
- Identification of significant concentrations of MDHDVs observed primarily in the W, NC, and SC subregions, with traffic volumes exceeding 50,000 truck trips per day in certain areas.
- Tailored recommendations generated to expedite the deployment of electric trucks and enhance charging infrastructure, aiming to drive sustainability and improve economic prospects in the transportation sector of the region.

Future Work

- Incorporating additional variables like meteorological conditions, traffic flow, and infrastructural attributes for enhanced analysis depth.
- Developing advanced models and predictive systems to optimize opportunity charging stations.
- Forecasting electric infrastructure demands and exploring various opportunity charging scenarios.

Thank you