# UNDERSTANDING VEHICLE CHOICE: SOCIOECONOMIC AND INFRASTRUCTURE FACTORS IN BATTERY ELECTRIC VEHICLE OWNERSHIP BASED ON ZIP CODE-LEVEL DATA IN THE SCAG REGION

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# Abstract

In recent years, legislative actions and social inequities have shaped the Electric Vehicle (EV) market. Amidst sociopolitical pressure to maximize greenhouse gas reductions in the face of climate change, the Southern California Association of Governments (SCAG) intends on maximizing EV ownership rates, specifically Battery Electric Vehicle (BEV) ownership rates, in order to conform with statewide and regional sustainability goals for greenhouse gas emissions reductions. Various assessments on mode choice, including those performed by SCAG, emphasize the role of socioeconomic variables such as median annual income and race/ethnicity in mode choice. However, few incorporate land-use adjacent variables such as population density or homeowner tenure, which upon closer examination, provide crucial links for meeting EV as noted by the American Community Survey (ACS)*'s 2022 American Community Survey Content Test Evaluation Report: Electric Vehicles*. By incorporating such variables into these analyses, particularly upon the advent of SCAG's upcoming calibration of its Activity Based Model (ABM) for BEV trip generation, the incorporation of relevant variables, particularly when examining the presence of physical and financial barriers for potential BEV owners, is crucial towards expanding BEV ownership within marginalized communities and meeting sustainability targets.

# Introduction

In recent years electric vehicles (EVs) have gained traction in the automobile marketplace, on a regional, statewide, and nationwide scale. This is visible from coordinated state and federal efforts over the last few years, including implementation of Executive Order N-79-20, which seeks to increase electric vehicle (EV) ownership to 100% of all new passenger vehicles sold by 2035 in California. (CARB, 202, Yu et al., 2023). These efforts are critical to meet the environmental goals and objectives of AB 32, which mandates a 30 percent reduction in greenhouse gas emissions (GHGs) below 1990 levels. (CARB, 2020),

Much of the existing literature on EVs primarily analyzes the novelty and general ownership trends of EVs. According to a study conducted by the National Research Council, NRC et al. 2015, which utilized a mixed methods approach to study nationwide trends for EV infrastructure and ownership, most EV owners are largely white, male, and reside in suburban areas where there is greater availability of charging access. Yu et al., 2023 utilized integrated traffic modeling to analyze the socioenvironmental implications of this policy on a regional scale. According to Yu et al., 2023, individuals living within census tracts classified under SB 535-designated for Disadvantaged Communities (DACs), or areas with a high proportion of low-income or minority populations, experienced worsened air quality as a result of lower EV ownership. Thus, improving EV ownership rates should be considered for sustainability as well as equity initiatives.

However, studying implications for equity and sustainability are often difficult and hard to apply to the SCAG region. Although equity remains a central part of the conversation towards encouraging EV adoption, applying the findings of these analyses to the context of the SCAG region is often difficult, with its varying geography, encompassing 191 cities and 6 counties within the southern California region. As such, applying a regional analysis of these trends, as opposed to either a broad nationwide or statewide analysis, or a local/smaller analysis with minimal variation, would inform members of Metropolitan Planning Organizations on crafting policies to encourage BEV ownership and charging station installation. Thus, in order to inform policies targeting EV, specifically Battery Electric Vehicle (BEV) ownership in the SCAG region, a regional analysis of current ownership trends  and charging station deployment should be conducted on an aggregate level. of these within the context of the SCAG Region, a Metropolitan Planning Organization with wide geographic variability , remain largely absent from existing literature.

The objective of this research is to analyze aggregate sociodemographic trends based on zip code-level aggregation of BEV ownership data to inform the upcoming calibration of

SCAG's Activity Based Model (ABM) for BEV Vehicle Type. Given the vastness of the SCAG region, encompassing 191 cities and 6 counties in California—Imperial County, Los Angeles County, Orange County, Riverside County, San Bernardino County, and Ventura County—performing such an analysis is crucial towards not only improving EV ownership rates and expanding charging station access, but also towards achieving social equity and sustainability goals.

## Literature Review

Various research articles studying ownership disparities and socioeconomic variables influencing EV ownership do so largely on either a statewide (primarily California) or national scale. , Given the broad scope of these analyses, and the fact in that EV ownership, charging station distribution, and access to EV rebate programs are often analyzed separately, it is difficult to apply the findings of these analyses to inform policy within the SCAG region.  An overview of the research conducted for each topical subject is provided below.

### 1. BEV Ownership

According to existing studies, EV ownership rates vary according across demographic groups, including amongst marginalized communities where factors such as language and housing tenure play a role in decisions to purchase an EV.

Yu et al. (2023), using vehicle registration information from CARB's Fleet Database, socioeconomic data from the Office of Environmental Health and Hazard Assessment (OEHHA) and CalEnviroScreen 4.0, and air particulate modeling software, found disparities in EV ownership rates to exist not only outside of, but within marginalized communities. According to the study, although DACs were found to consist of lower EV ownership rates; with respect to EV ownership trends in other DACs, Black- and Hispanic/Latino-dominant DACs displayed much lower EV ownership levels. While these conclusions support policies incorporating a community-level approach for encouraging ownership equity, the findings of this study are non-comprehensive by failing to factor in charging station availability; a key metric, as later noted, towards motivating purchase of an EV.

SCAG currently analyzes trends for Vehicle Type based on median annual income, median household size, and race/ethnicity, thus excluding consideration of other variables which may possibly influence EV ownership. According to the 2022 American Community Survey (ACS)'s Content Test Evaluation Report: Electric Vehicles, factors such as zoning, age housing tenure, English proficiency, and survey responsiveness (i.e. likeliness to respond) are also significant metrics for studying EV ownership trends in addition to those already considered by SCAG. To verify the significance of these findings, however, examination of these variables on a regional level is warranted in order to verify the implications of memorandum for the SCAG region.

## 2. Charging Station Distribution

Studies on EV charging station (hereafter referred to as "charging station") availability analyze both physical (e.g. presence of charging station ports) and socioeconomic (e.g. racial, financial) barriers to EV ownership.

Hsu & Fingerman, 2021's analysis of census block groups across the state of California, compiled from data from the ACS and U.S. Census Bureau for sociodemographic trends, found that Black- and Latino-dominant communities experienced lower proximity to charging stations, even when adjusted for adjacency to transportation corridors (a key metric for charging station installation, according to SCAG's *Clean Technology Compendium* [SCAG, 2022]).

However, this study was limited to generalized statewide trends, failing to examine regional conditions specific to the SCAG region. Furthermore, this analysis only considered charging station locations within urban areas, thus excluding analysis on the presence of EV charging stations in non-urban areas, which comprise the majority of the SCAG region. Thus, the conclusions of Hsu & Fingerman, 2021 are limited to studying generalized charging station trends within high-density urban areas, thus excluding other factors, including those impacting charging station availability, as noted by NRC et al., 2015.

NRC et al., 2015, through data derived from the U.S. Census Bureau and U.S. DOE, found that the vast majority of EV owners (~80%), live in suburban areas with access to charging station infrastructure. Furthermore, the study found this to be a significant factor in terms of overall charging use, with residential charging comprising up to 80% of overall charging. Analyzing these patterns and the lack of EV ownership in dense urban areas with minimal charging station infrastructure, including those for parking garages within multifamily complexes, was found to be a significant constraint in terms of overall charging station access, and thus overall EV ownership.

While the conclusions of these study provide implications for land use, similar to Hsu & Fingerman, 2021, the findings of this study, which were done on a nationwide scale, making it difficult to apply to the SCAG region. Furthermore, the study failed to reference applicable policies or regulations influencing the installation of EV charging stations, further obscuring the applicability of these findings to influencing local reform or initiatives. Therefore, the findings of NRC et al., 2015 and Hsu & Fingerman, 2021, have yet to be applied on a regional basis for influencing MPO policy on EVs. To address these deficiencies, this study aims to examine the applicability of these findings specific to the SCAG region.

## 3. EV Reimbursement Program Participation

Most studies on the efficacy of EV reimbursement programs find that such initiatives cater disproportionately to affluent communities instead of DACs, despite efforts to bolster equity in BEV ownership.

Programs widely used in the SCAG region, including CARB's Clean Vehicle Rebate Program (CVRP), are studied in Connelly et al., 2024. According to the study, using sociodemographic data sourced from the 2016 ACS and U.S. Census Bureau, as well as information on DAC classification from OEHHA's CalEnviroScreen 4.0, disparities in EV rebate program participation vary widely between statewide and regional programs. The study analyzed three statewide programs (the CVRP, the Clean Vehicle Assistance Program [CVAP], and the California Clean Fuel Reward [CCFR]) and three regional programs (Clean Cars for All [CC4A], the Drive Clean in the San Joaquin Rebate Program (DCSJ-RP], and the Southern California Edison Pre-Owned EV Rebate Program [SCE-PreOR]. According to the study, although regional rebate programs such as the SCE-PreOR showed much higher DAC participation rates, the CVRP, a statewide program accounting for 96.5% of all reimbursement funds studied, is heavily skewed towards non-DAC census tracts, with DACs comprising of only 12.1% of funding recipients throughout the life of the program (which lasted from 2010 to the second quarter of 2023). (Connelly et al., 2024, 6) As such, the characteristics of most participating jurisdictions, paralleling the findings of Yu et al., 2023 and Hsu & Fingerman, 2021, were comprised of high-income earners residing in suburban areas. Thus, although regional programs resulted in more equitable rates, as noted by the researcher, "the dominant size of CVRP and CCFR in funding terms means that overall statewide performance is lackluster despite the relative success of regional programs." (Connelly et al., 2024, 7) As such, the overwhelming dominance of the CVRP and CCFR in program funding resulted in an overall DAC participation rate of only 16% across all studied programs.

In spite of these findings, however, the scope of Connelly et al., 2024 was limited to EV rebate program participation within urban areas, failing to account for geographical variation for DACs located elsewhere. Furthermore, the study failed to consider the heterogeneity of DACs, or other marginalized communities participating in such programs (i.e. whether or not these rates different between Hispanic/Latino and Black communities, per the findings of Yu et al., 2023), thus further limiting the applicability of these findings on an aggregate level within the SCAG region. This study seeks to correct for these disparities by analyze socioeconomic variation across communities in the SCAG region in order to recommend relevant policy initiatives for improving EV rebate program participation rates, and thus BEV ownership.

Mejia-Duwan et al., 2023 analyzes the success of the CVRP further, analyzing the socioenvironmental implications of it and other EV policies through compilation of data sourced from various government databases and modeling platforms to assess aggregate greenhouse gas emissions reductions resulting from the program's implementation. Due to lower CVRP participation rates, the study found that non-DACs, primarily affluent communities, benefitted from improved air quality levels as opposed to DACs, further emphasizing the benefits espoused in Yu et al., 2023 on improving EV ownership rates within marginalized communities.

However, similar to Connelly et al., 2024 and previous studies analyzed, the study failed to incorporate these findings on a level similar to that of the SCAG region. Whilst an examination of possible impacts on greenhouse gas emissions is outside of the scope of this study, this research aims to utilize the findings of this regional analysis to advance local sustainability goals and equity initiatives as a result of improved BEV ownership rates.

To successfully conduct a regional analysis of these trends, and to correct for the disparities observed in the aforementioned studies, this study aims to achieve the following:

1) A SCAG-specific analysis of BEV ownership rates, charging station distribution, and EV reimbursement program (CVRP) participation rates. This would incorporate charging station capacity in terms of available ports and population density and would encompass the entire vicinity of the SCAG region, not exclusive of urbanized areas.
2) A zip code-level analysis of various socioeconomic factors, including race/ethnicity, median household income, and household size. This would inclusive of factors found to be significant by ACS, 2022 in terms of influencing EV ownership, including age, English proficiency, and homeowner tenure.

Based on the findings of these analyses, this study seeks to provide a list of recommendations for expanding BEV ownership, charging station distribution, and EV program participation rates to better inform existing policy initiatives within the SCAG region.

**Table 1a: Distribution of Literature Findings by Type**

| Studies | Study Area | Research Question | Data Source | Unit of Analysis | Major Findings | Limitations |
|---|---|---|---|---|---|---|
| **EV/BEV Ownership** | | | | | | |
| ACS, 2022 | United States | Validity of question on EV energy consumption | ACS; U.S. Census Bureau; Energy Information Administration; U.S. OMB | households | Zoning, English proficiency, housing tenure, age, and survey responsiveness are important determinants in BEV ownership. | Limited to national analysis |
| SCAG, 2024 | SCAG Region | Household inputs for travel behavior | ACS; U.S. Census Bureau; CA DOF, CA EDD; firm-based InfoGroup data; 2019 County Assessor's Pacel Database | households | Median annual income, median household size, and race/ethnicity are important determinants in BEV ownership. | Limited to ICVs |
| Yu et al., 2023 | Los Angeles County | Equity implications of EV transition (air quality) | Cal EnviroScreen 4.0, CARB Fleet Database; EMFAC 2021v1.0.2 | EVs | DACs contain lower EV ownership rates than non-DACs, but this is particularly true for Black- and Latino-dominant DACs. | Lack of analysis of EV charging station distribution |
| **Charging Station Distribution** | | | | | | |
| Hsu & Fingerman at al., 2021 | California | Equity implications of EV transition (public EV charging station distribution) | ACS 5-yr. data (2019); U.S. DOE; US. Census Bureau | charging station | Black and Latino communities are less likely to live adjacent to public EV charging stations regardless of proximity to transportation corridors. | Limited to urban areas; limited to public charging stations |

| | | | | | | |
|---|---|---|---|---|---|---|
| NRC et al., 2015 | United States | Barriers to EV adoption and development | U.S. Census Bureau; U.S. DOE; FHWA, Consumers Union | charging station | The vast majority (80%) of EV owners live in suburban areas with access to charging areas, where the majority of charging takes place. Lower BEV ownership exists in dense urban areas due to lack of charging stations in multifamily units. | Limited to national analysis |
| **EV Reimbursement Program Participation** | | | | | | |
| Connolly, 2024 | Greater Los Angeles Area | Equity implications of EV transition | CalEnviroScreen 4.0; U.S. Census Bureau; ACS 5-Yr Data (2019); EMFAC 2021v1.0.2 | $ funding | Participation in the CVRP and larger statewide programs is heavily skewed towards non-DACS (with DACs accounting for only 12.1% of funding recipients). Participants were more likely to be of middle- to high-income earning status and to reside in suburban areas. Although regional programs consisted of more equitable participation, the dominance of the CVRP and other statewide programs resulted in disproportionately low DAC participation across the board. Within urban areas, jurisdictions receiving high rates of CVRP participation and those receiving low rates of participation were | Limited to urban areas; lack of analysis of EV charging station distribution |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | found to exist in close proximity to one another. | |
| Mejía-Duwan et al., 2023 | California | Equity Implications of CVRP Program (air quality) | Cal EnviroScreen 4.0; EMFAC 2021v1.0.2 | EVs | Non-DACs are more likely to benefit from emissions reductions than DACs as a result of disproportionate participation in the CVRP. | Limited to statewide |

## Methods

This project analyzed BEV ownership, public charging station distribution, and EV Reimbursement Program Participation across variables already incorporated by SCAG to study travel behavior, hereafter referred to as “SCAG-Considered Variables”. This study also conducted a separate analysis on these relationships for variables not considered by SCAG and found to be significant under ACS, 2022, referred to as “ACS-Considered Variables”. A full list of the SCAG-considered and ACS-considered variables analyzed is provided in Table 2b.

**Table 2a: SCAG-Considered Variables vs. ACS-Considered Variables**

| SCAG-Considered Variables | ACS-Considered Variables[1] |
|---|---|
| Median Household Income | Median Age |
| Median Household Size | Homeowner Tenure (Homeowner vs. Renter) |
| Race/Ethnicity | English Language Proficiency |

To conduct these analyses, a zip code polygon layer from the U.S. Census (see Table 3a below) was used to select zip codes in the SCAG region by location within a county polygon layer through tl_2024_us_county (U.S. Census, 2024). Following this, spatial joins and exports were conducted to provide layers for each socioeconomic variable. To inform the distribution of public charging stations, a point layer was extracted from California Energy Commission (CEC), “Stations that Meet NEV Requirements (March 2024)”, and a polyline layer, “Corridor Groups”. Finally, to inform participation in E.V. reimbursement programs (CVRP) in the SCAG region, a polygon layer from the California Air Resource Board (CARB)’s Center for Sustainable Energy was used. A tabulated summary of these data sources is provided in Table 3a.

[1] Due to limited scope, and novelty of EV surveying in the SCAG region, there is a lack of an established precedent in analyzing survey responsiveness between high/low response areas. Therefore, while response rates was be noted for contextual purposes in the following observations, this was not examined on a spatial scale due to the lack of ACS data to compare it to. Additionally, since building (zoning) is not a socioeconomic characteristic and thus is not directly tied to BEV ownership, this variable was also considered for contextual purposes but not studied on a spatial scale.

**Table 3a: Data Sources**

| Dataset Name | Source | Variables | Aggregation | Method for Obtaining Data |
|---|---|---|---|---|
| ZIP Code Tabulation Area | • U.S. Census Bureau, TIGER/Line Shapefiles | • ZCTA5CE20<br>• GEOID20 | Zip code | Downloaded from U.S. Census Bureau Website |
| County | • U.S. Census Bureau, TIGER/Line Shapefiles | • State FP<br>• County FP<br>• Name<br>• NAMELSAD | Zip code | Downloaded from U.S. Census Bureau Website |
| Vehicle Fue Type by Zip Code | • California Department of Motor Vehicles | • Model year<br>• Fuel<br>• Make<br>• Duty<br>• No. vehicles | Zip code | Downloaded from CA Open Data Portal website |
| Table S1101: Households and Families | • U.S. Census Bureau, American Community Survey 5-year estimates, 2018-2022. | • Median Household Size | Zip code | Downloaded from U.S. Census Bureau Website |
| Table B19001: Household Income in the Past 12 Months in 2022 Inflation-Adjusted Dollars | • U.S. Census Bureau, American Community Survey 5-year estimates, 2018-2022. | • Median Annual Income | Zip code | Downloaded from U.S. Census Bureau Website |
| Table S25002: Demographic Characteristics of Occupied Housing Units | • U.S. Census Bureau, American Community Survey 5-year estimates, 2018-2022. | • White Population<br>• Black Population<br>• Asian Population | Zip code | Downloaded from U.S. Census Bureau Website |

| | | | | |
|---|---|---|---|---|
| | | • Hispanic/Latino Population | | |
| Table DP05: ACS Demographic and Housing Estimates | • U.S. Census Bureau, American Community Survey 5-year estimates, 2018-2022. | • Median age<br>• Population Density [calculated] | Zip code | Downloaded from U.S. Census Bureau Website |
| Table B25003: Tenure | • U.S. Census Bureau, American Community Survey 5-year estimates, 2018-2022. | • Homeowner Population<br>• Renter Population | Zip code | Downloaded from U.S. Census Bureau Website |
| Table B16002: Detailed Household Language by Household Limited English-Speaking Status | • U.S. Census Bureau, American Community Survey 5-year estimates, 2018-2022. | • Limited English Proficiency | Zip code | Downloaded from U.S. Census Bureau Website |
| Section 21072: Qualified Urban Land Use: Definition | • *2023 CEQA: California Environmental Quality Act Statues & Guidelines* | • Urban vs. Non-Urban Land Use | Zip code | Viewed from California Association of Environmental Professionals Website |
| Stations that Meet NEVI Requirements (March 2024) | • U.S. Department of Energy's Alternative Fuels Data Center Station Data for Alternative Fuel Corridors | • Fuel Type Code<br>• Station Name<br>• Street Address<br>• City<br>• State<br>• Zip Code<br>• Groups with Access Code (Public/Private) | Zip code | Downloaded from CEC Arc GIS Open Data Portal |

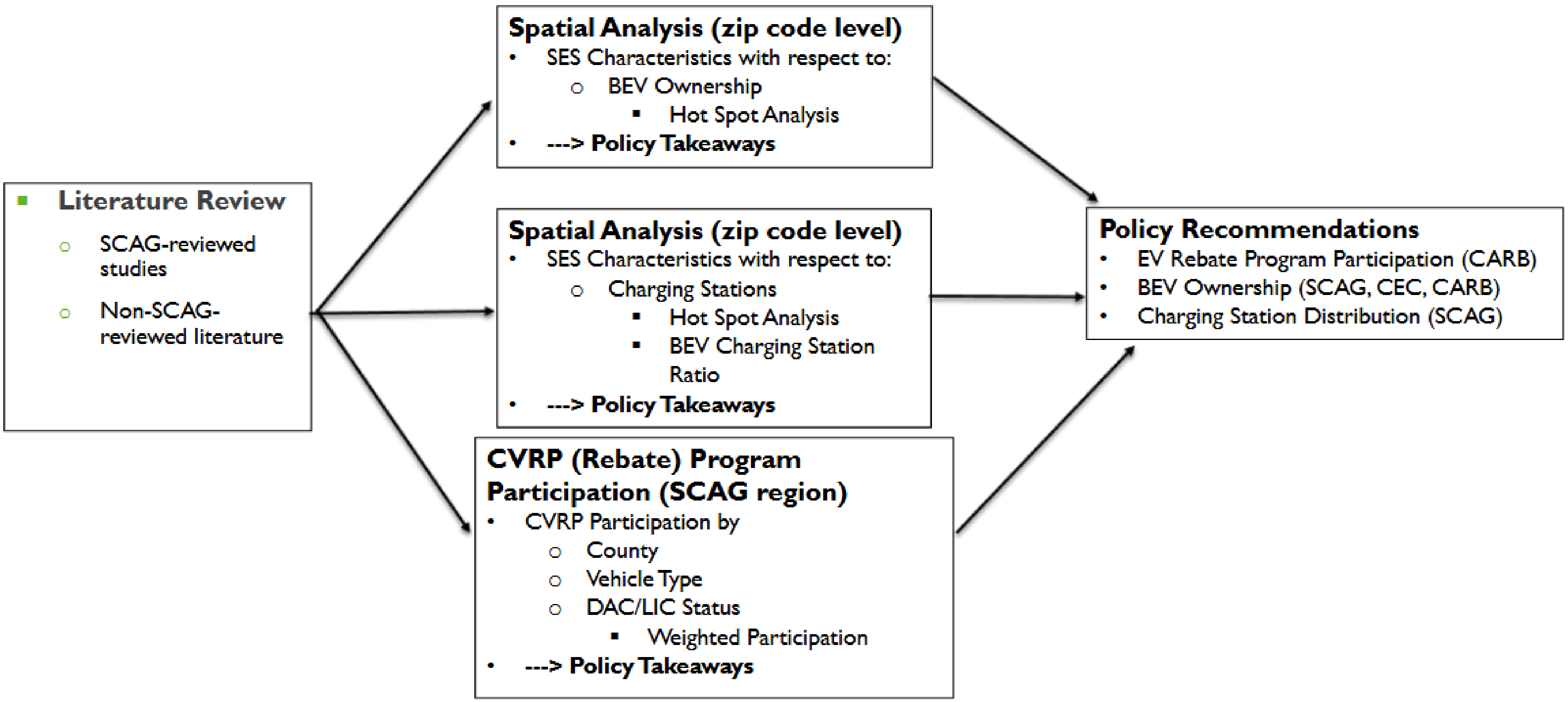
| | | | | |
|---|---|---|---|---|
| | | • EV Level 2 EVSE Num<br>• EV DC Fast Count<br>• Latitude<br>• Longitude<br>• ID<br>• Owner Station Code | | |
| Corridor Groups (December 9, 2024) | • U.S. Department of Energy's Alternative Fuels Data Center Station Data for Alternative Fuel Corridors | • Charging Stations | N/A | Downloaded from CEC Arc GIS Open Data Portal |
| CA Light-Duty ZEV Incentive Programs Insights | • California Air Resources Board Center for Sustainable Energy | • ID<br>• Data Source [CVRP]<br>• Year of Application Date<br>• Vehicle Type<br>• Vehicle Make<br>• DAC/LIC Status<br>• City<br>• County<br>• Air District<br>• Assembly District<br>• Zip/Postal Code | Zip code | |

To develop a preliminary framework of spatial analysis of socioeconomic features and charging station accessibility, this analysis also chose to include population density, based on the recommendations of SCAG. By utilizing the aforementioned data sources, collected from various governmental agencies, including CARB and the CEC, this study provides the following:

1. An analysis on SCAG-considered factors and ACS-considered factors, which was used to provide recommendations for adjusting the SCAG model based on trends found from spatial analysis observations and hot spot analysis comparisons. For ACS-considered variables, this included all variables that were found to be significant from (ACS, 2022) save for survey responsiveness and land use[2].
2. An analysis of the ratio of BEV owners: Charging station (BEV_CS) within the SCAG region, with the purpose of identifying specific zip codes and their characteristics for targeting BEV ownership and charging station expansion.
3. A comprehensive list of policy recommendations for SCAG with the aim of understanding EV ownership trends to inform SCAG's policy aims to improve ownership rates in DAC communities. This included policies targeting improving participation rates amongst DACs in EV Incentive programs, EV ownership rates amongst DACs, and equitable charging station distribution.

[2] Ibid.

## Data Flowchart



## Results

### 1. BEV Ownership

The results of this study found disparities within both BEV ownership and charging station distribution throughout the SCAG region.

Based on data sourced from DMV, 2023, there are 14,138,010 vehicles registered in the SCAG region, and approximately 526,303 (3.72%) of these are BEVs. The breakdown of BEVs amongst all registered vehicles was analyzed across the SCAG region. In addition, the distribution of urban and non-urban areas in the SCAG region was also analyzed to assess BEV ownership rates relative to land use policies. To provide a disaggregate analysis consistent with the use of zip codes as the geographic unit for this spatial analysis, the California Public Resources Code Section 21071's definition of urbanity for unincorporated areas was used, or for population density of at least 5,000 persons per square mile or higher (PRC Section 2171(b) was used. (AEP, 2023) Based on available population from the ACS 5-Year Community Survey (2018-2022), this was used to calculate BEV ownership within urban and non-urban areas. The results of these calculations are shown in Table 1b below.

**Table 1b: Breakdown of BEV Ownership in the SCAG Region**

| | Total # of BEVs | % BEV Ownership as % of All Vehicle Types | Pop. Density (>/=5,000 persons per sq mi) | Pop. Density (< 5,000 persons per sq mi) |
|---|---|---|---|---|
| **Imperial** | 756 | 0.40% | 0.40% | N/A |
| **Los Angeles** | 299,327 | 4.0% | 3.4% | 5.4% |
| **Orange** | 131,311 | 5.4% | 4.3% | 7.8% |
| **Riverside** | 52,267 | 2.6% | 1.9% | 2.6% |
| **San Bernardino** | 24,779 | 1.8% | 1.8% | 1.8% |
| **Ventura** | 17,863 | 2.9% | 2.8% | 2.9% |
| **SCAG Region** | 525,127 | 3.7% | 3.5% | 4.0% |

Although Los Angeles County reported the highest number of BEVs of any county within the SCAG region (299,327), Orange County reported the highest proportion of BEVs in overall vehicles than any county (5.42% of total vehicles).

To analyze the relationship between BEV ownership trends and socioeconomic demographic data, an analysis of variables already incorporated by SCAG to study travel behavior (i.e. "SCAG-Considered Variables") and variables not considered by SCAG, and found to be significant under ACS, 2022 ("ACS-Considered Variables") was conducted. A full list between SCAG-considered and ACS-considered variables used in this spatial analysis is provided in Table 2b.

**Table 2b: SCAG-Considered Variables vs. ACS-Considered Variables**

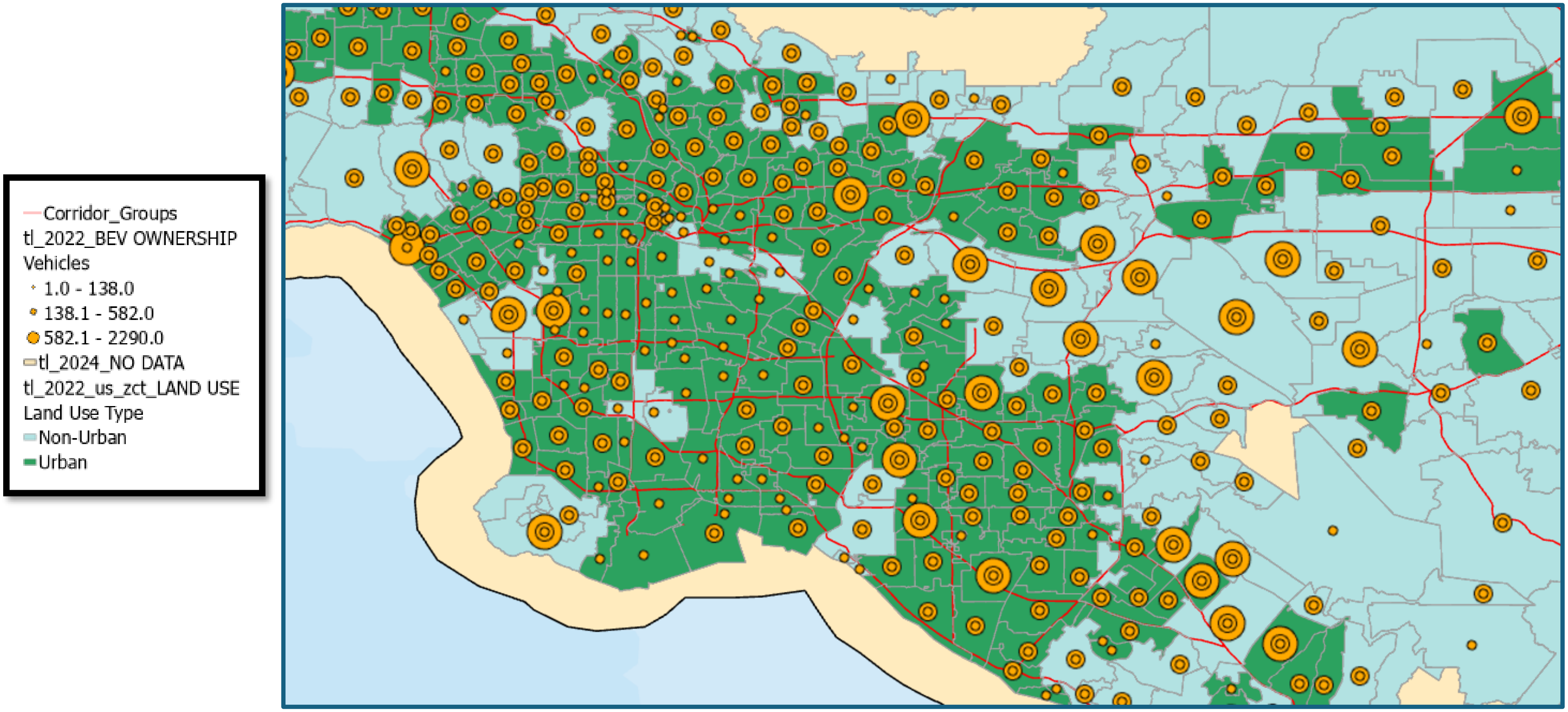
| SCAG-Considered Variables | ACS-Considered Variables |
|---|---|
| Median Household Income | Median Age |
| Median Household Size | Homeowner Tenure (Homeowner vs. Renter) |
| Race/Ethnicity | English Language Proficiency |

To inform the geographic distribution of BEV ownership trends, both urban vs. non-urban land uses and population density were studied with respect to BEV ownership. To contextualize subsequent analyses for land use, urban/non-urban land use was studied first prior to those conducted for SCAG-considered variables (Fig. 1a). To inform the impacts of homeowner tenure and land use on BEV ownership, analyses for population density preceded those conducted for ACS-considered variables (Fig. 8a).

### *SCAG-Considered Variables*

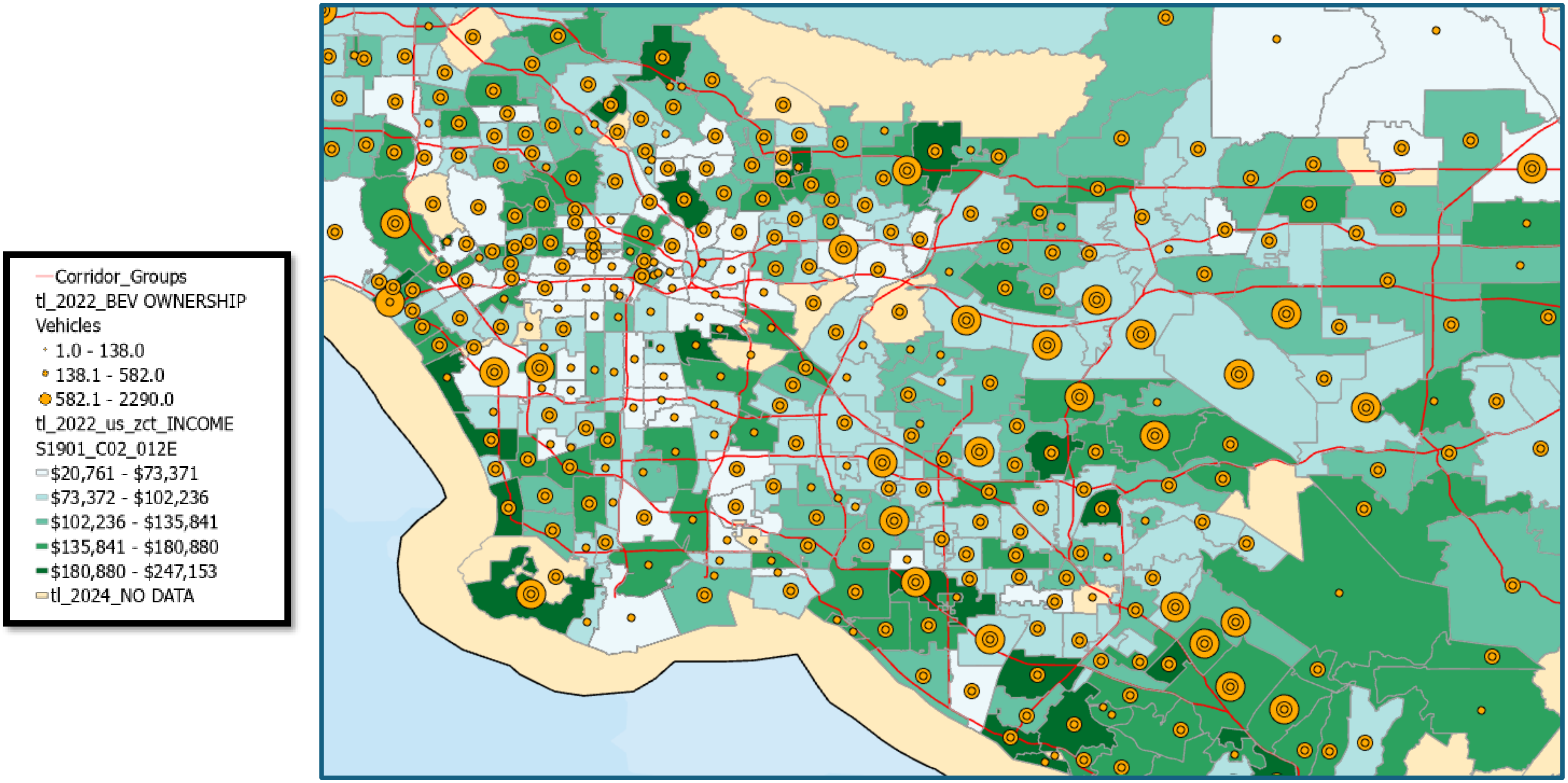
Prior to analyzing the relationship between BEV ownership and SCAG-considered variables, this spatial analysis analyzes the distribution of urban vs. non-urban land uses with respect to BEV ownership (Fig. 1a) followed by SCAG-considered variables for median annual income, median household size, and race/ethnicity. (Fig.2b, Fig. 3b, Fig. 4b, Fig.5b, Fig.6b, Fig.7b). To inform discussions on BEV ownership within the context of charging station availability, or the number of BEVs per public charging station (BEV_CS), this ratio was also provided to examine observed outliers.

Fig.1b BEV Ownership vs. Land Use (Urban vs. Non-Urban)



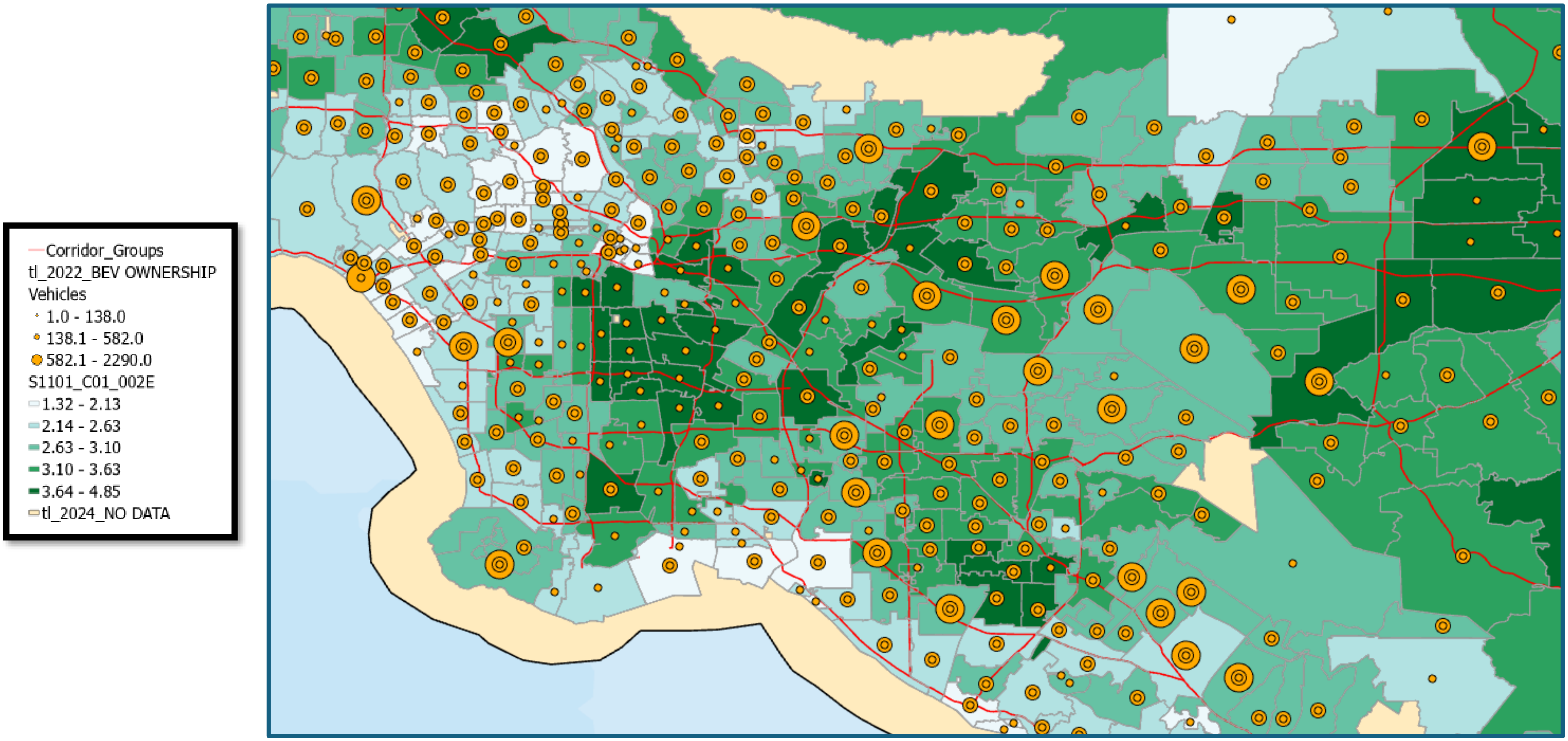

Paralleling Table 1, the majority of BEV owner exist in non-Urban areas; however, outliers exist within East Los Angeles, San Bernardino and West Riverside counties, particularly along Hwy.10.

Fig.2b BEV Ownership vs. Median Annual Income




A proportional relationship is observed between median annual income and BEV ownership, particularly within West Los Angeles and Orange County, consistent with Yu et al, 2023. However, these trends remain less persistent when traveling eastward towards Riverside and San Bernardino counties.

Fig. 3b BEV Ownership with Respect to Median Household Size




Unlike that observed for median annual income income, an inverse relationship exists between BEV ownership and median household size. Similar to the findings for median annual income, this also becomes less true as one travel eastwards.

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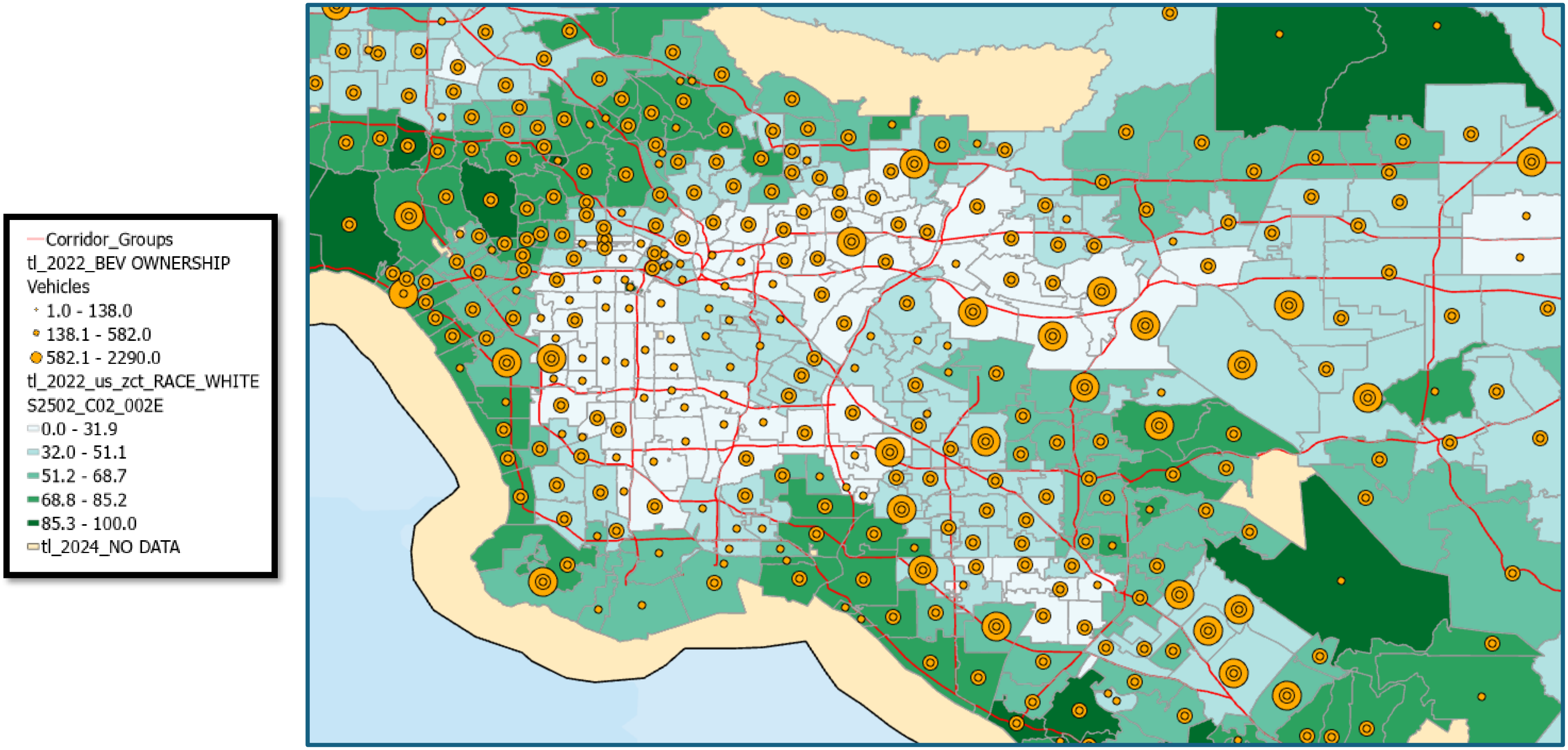
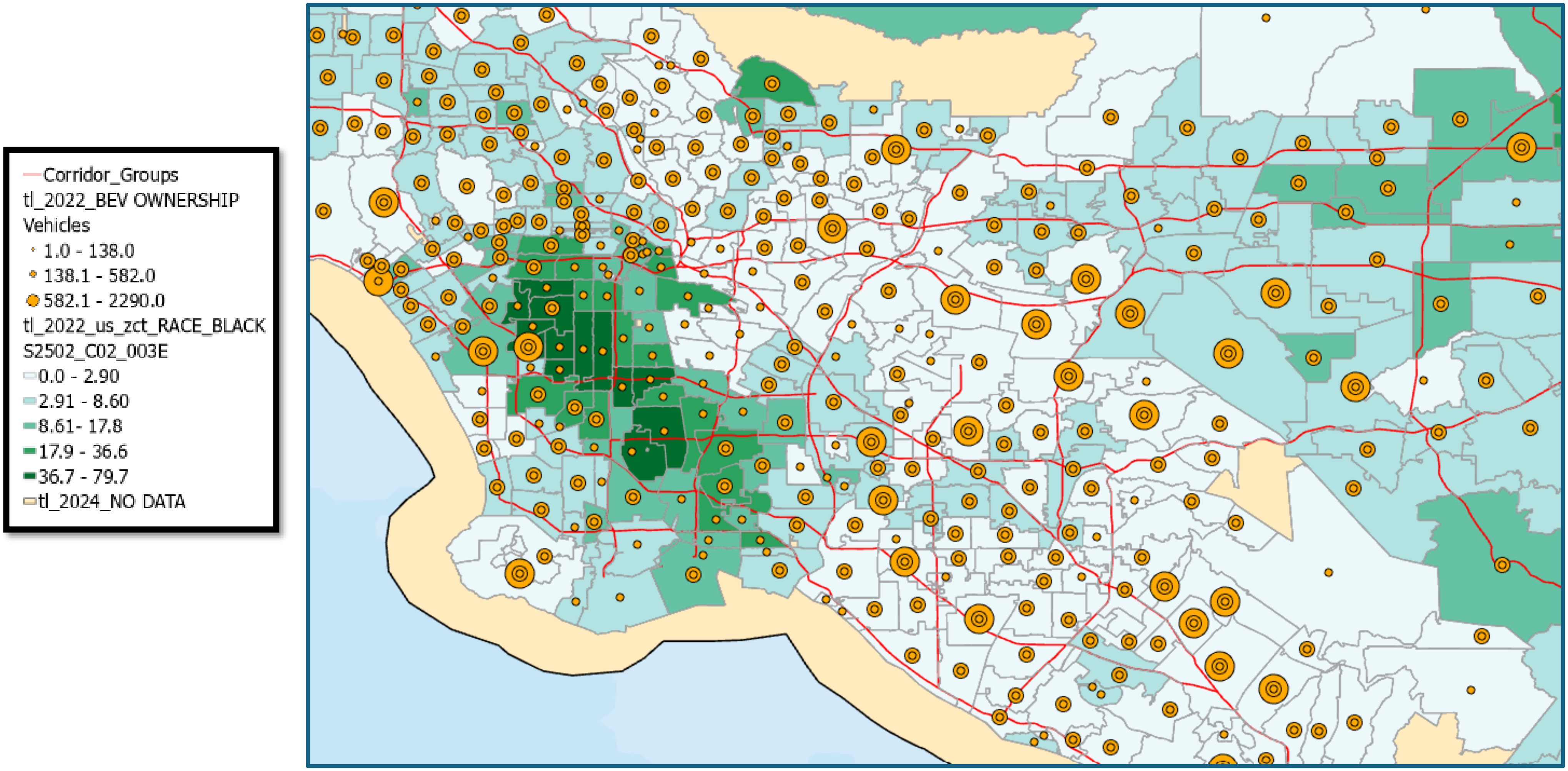
Fig. 4b BEV Ownership vs. White Population



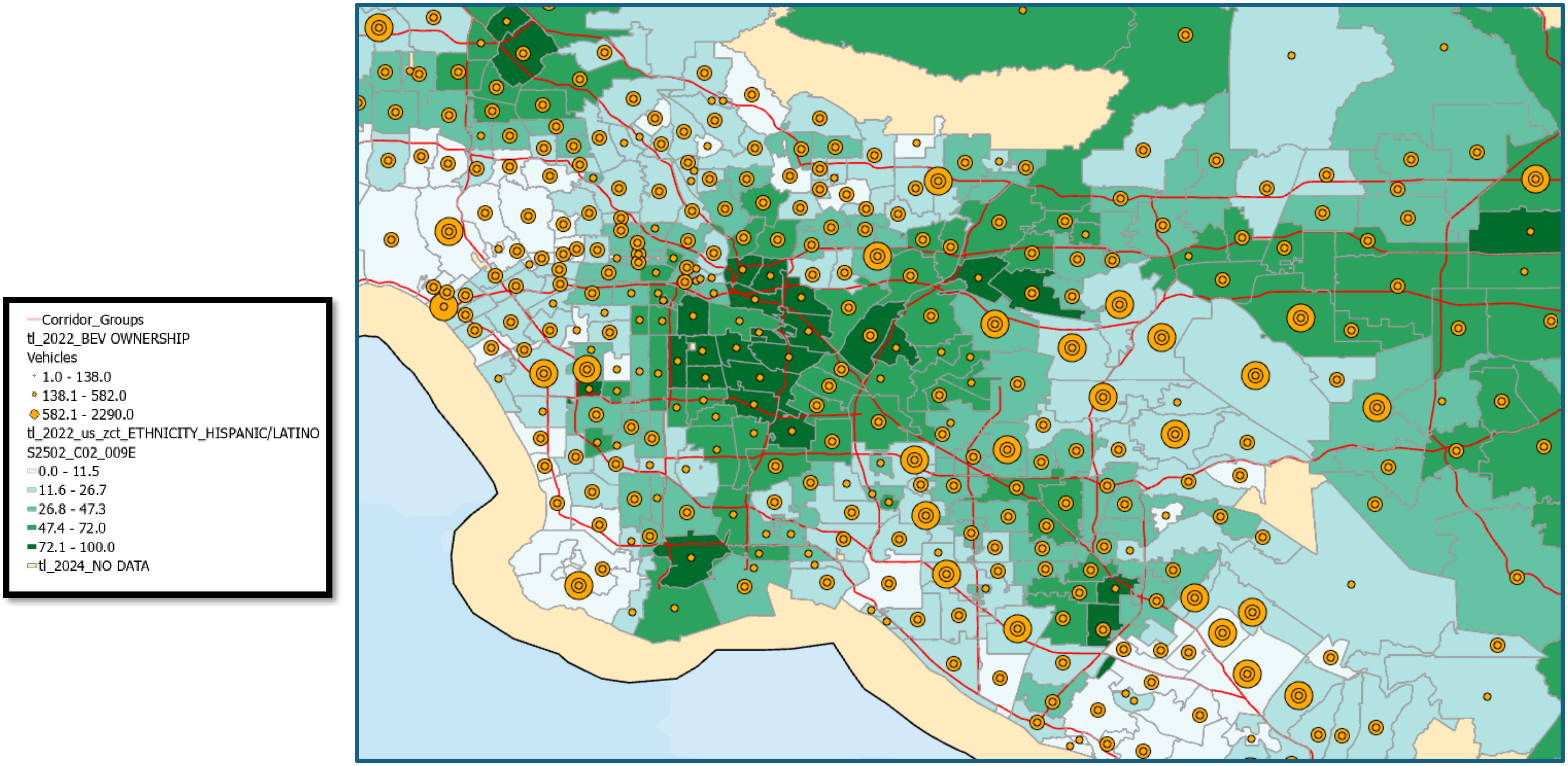

Similar to both median annual income and median household size, a proportional relationship exists between BEV ownership and White population, consistent with NRC et al., 2015, and Yu et al., 2023. However, this relationship becomes less apparent in non-urban areas (see Fig. 1b) within East Los Angeles and San Bernardino County.

Fig. 5b BEV Ownership vs. Black Population



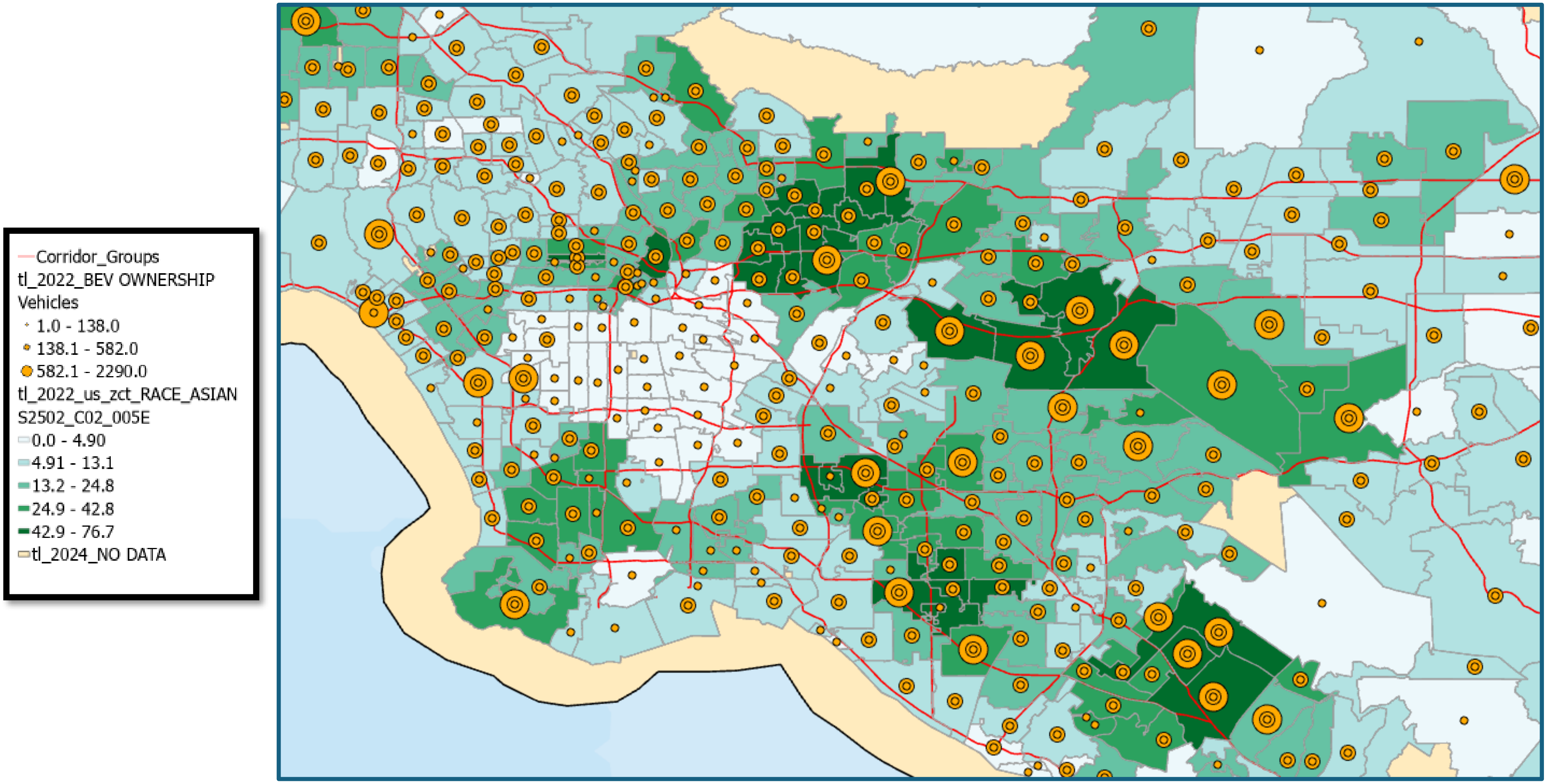

There is an inverse relationship between BEV ownership and Black population paralleling the findings Yu et al., 2023, however, this trends holds less true for non-urban areas (see Fig. 1a), particularly along transportation corridors.

Fig. 6b BEV Ownership vs. Hispanic/Latino Population (Regardless of Race)




An inverse relationship exists between BEV ownership and Hispanic/Latino population, similar to the relationship observed between BEV ownership and Black population (Fig. 4a) and BEV ownership. Given that the geographic spread is greater, further confirming the findings of Yu et al., 2023, outliers to these patterns exist within non-urban areas near transportation corridors, particularly within East Los Angeles, San Bernardino, and West Riverside counties.

Fig. 7b BEV Ownership vs. Asian Population




A positive relationship exists between BEV ownership and Asian population, and these rates are highest adjacent to transportation corridors.

## Summary

A high degree of overlap was observed between BEV ownership and median income, BEV ownership and White population, and BEV ownership and Asian population. An inverse relationship was observed between BEV ownership and household size, BEV ownership and Black population, and BEV ownership and Hispanic/Latino population, affirming the findings of Yu et al., 2023 on the presence of an inverse relationship between BEV ownership rates and Black and Hispanic/Latino populations in particular. However, the strength of these trends fades when analyzing for non-urban areas adjacent to transportation corridors, particularly within East Los Angeles County, San Bernardino County, and Riverside County. The characteristics of outliers to these trends are further examined below:

1. **Zip code: 91770**

| **Jurisdiction(s)** | **Fontana** |
|---|---|
| Median Income | $71,782 |
| Median Household Size | 3.56 |
| White Pop. | 25.7% |
| Black Pop. | 0.40% |
| Hispanic/Latino Pop. (regardless of race) | 16.2% |
| Asian Pop. | 61.2% |
| BEV: Charging Station Ratio | 203 |

2. **Zip Code: 91789**

| **Jurisdiction(s)** | **Walnut** |
|---|---|
| Median Income | $90,446 |
| Median Household Size | 3.25 |
| White Pop. | 18.5% |
| Black Pop. | 2.8% |
| Hispanic/Latino Pop. (regardless of race) | 16.0% |
| Asian Pop. | 65.9% |
| BEV: Charging Station Ratio | 35 |

3. **Zip Code: 91733**

| **Jurisdiction(s)** | **South El Monte** |
|---|---|
| Median Income | $62,407 |

| | |
|---|---|
| Median Household Size | 3.89 |
| White Pop. | 21.2% |
| Black Pop. | 0.60% |
| Hispanic/Latino Pop. (regardless of race) | 68.8% |
| Asian Pop. | 25.5% |
| BEV: Charging Station Ratio | 83 |

4. **Zip Code: 90301**

| **Jurisdiction(s)** | **Inglewood** |
|---|---|
| Median Income | $154,792 |
| Median Household Size | 2.89 |
| White Pop. | 17.4% |
| Black Pop. | 39.2% |
| Hispanic/Latino Pop. (regardless of race) | 46.6% |
| Asian Pop. | 3.5% |
| BEV: Charging Station Ratio | 266 |

5. **Zip Code: 92833**

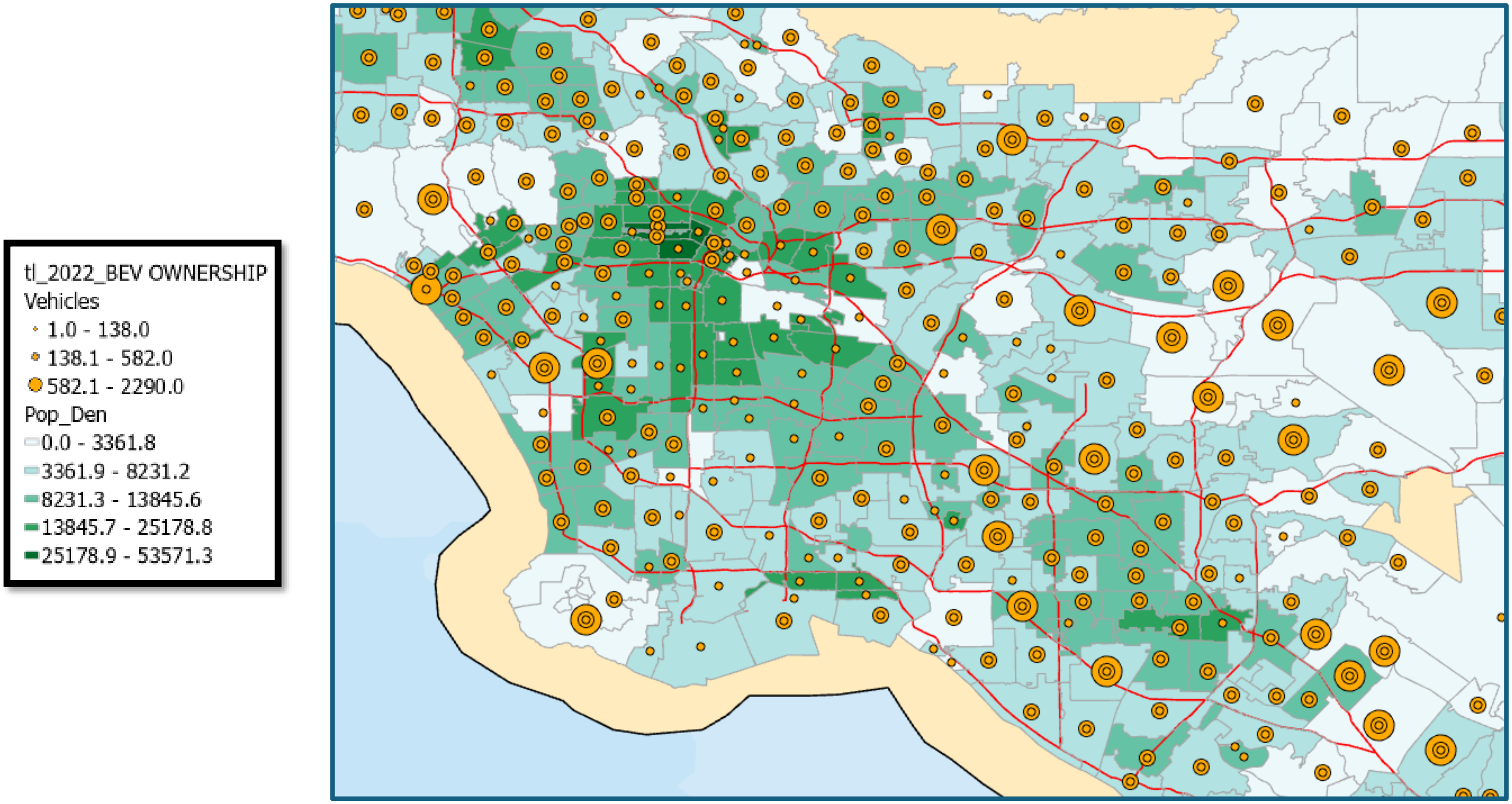
| **Jurisdiction(s)** | **Fullerton** |
|---|---|
| Median Income | $97,825 |
| Median Household Size | 3.19 |
| White Pop. | 40.2% |
| Black Pop. | 1.4% |
| Hispanic/Latino Pop. (regardless of race) | 30.8% |
| Asian Pop. | 37.0% |
| BEV: Charging Station Ratio | 165 |

Outliers contained lower median annual incomes, larger household sizes, and/or higher proportions of minority populations than non-outliers. Given the location of these outliers within or in proximity to non-urban areas (Fig.1a), opportunities for expanding public charging station access within these localities could be evaluated further, especially along Hwy. 10 (see further discussion in 3. EV Reimbursement Program Participation).

### *ACS-Considered Variables*

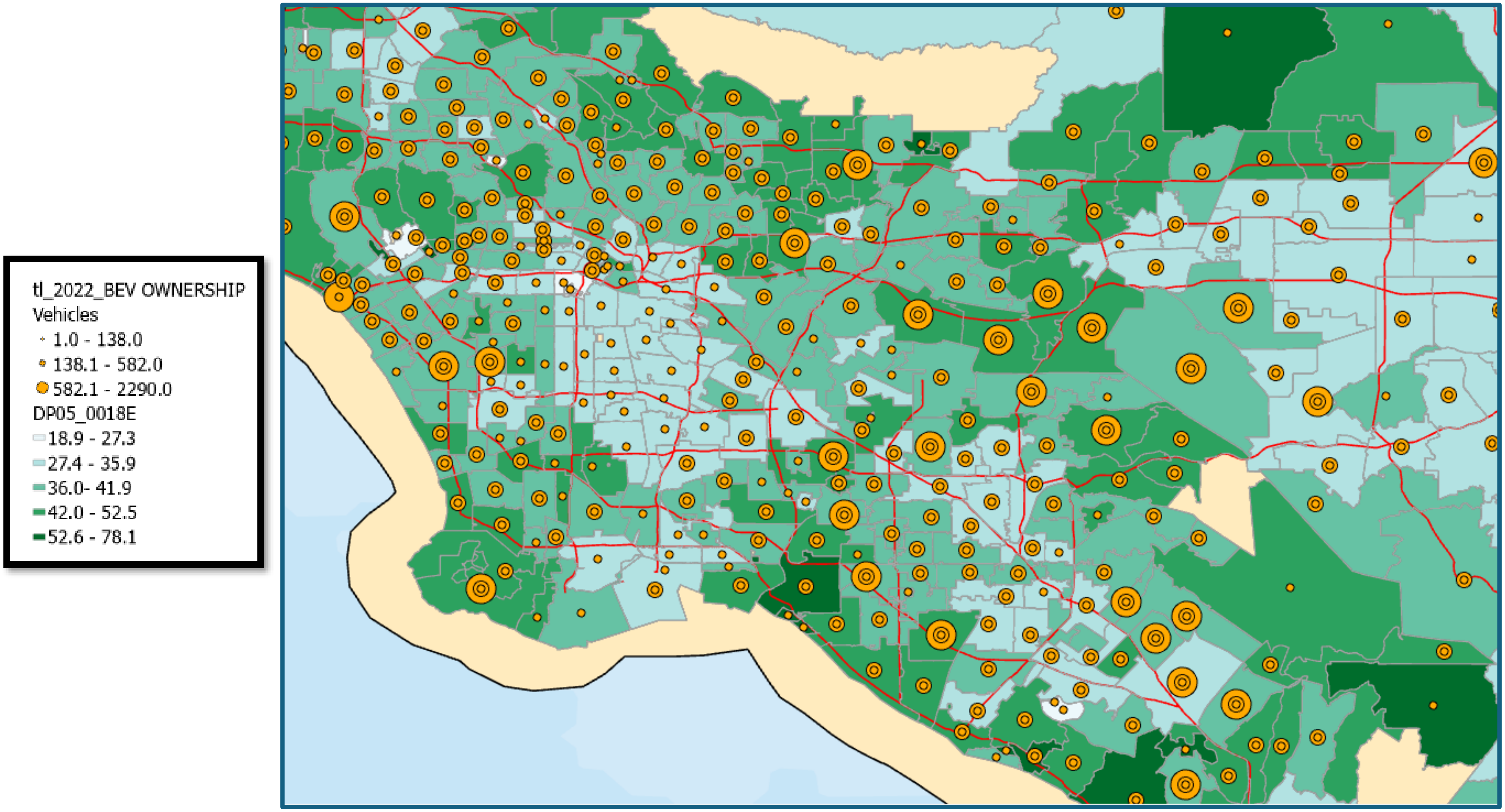
Following analysis of SCAG-considered variables, ACS-considered variables, or variables found to be significant in impacting BEV ownership in ACS, 2022, were also analyzed spatially. As previously mentioned, the relationship between population density and BEV ownership was analyzed first to inform analyses of impacts related to land use and homeowner tenure (Fig. 8b). This analysis was followed by those conducted for ACS-considered variables, including median age (Fig. 9b), homeowner population (Fig. 10b), renter population (Fig. 11b), and limited English proficiency (Fig. 12b).

Fig.8b BEV Ownership vs. Population Density



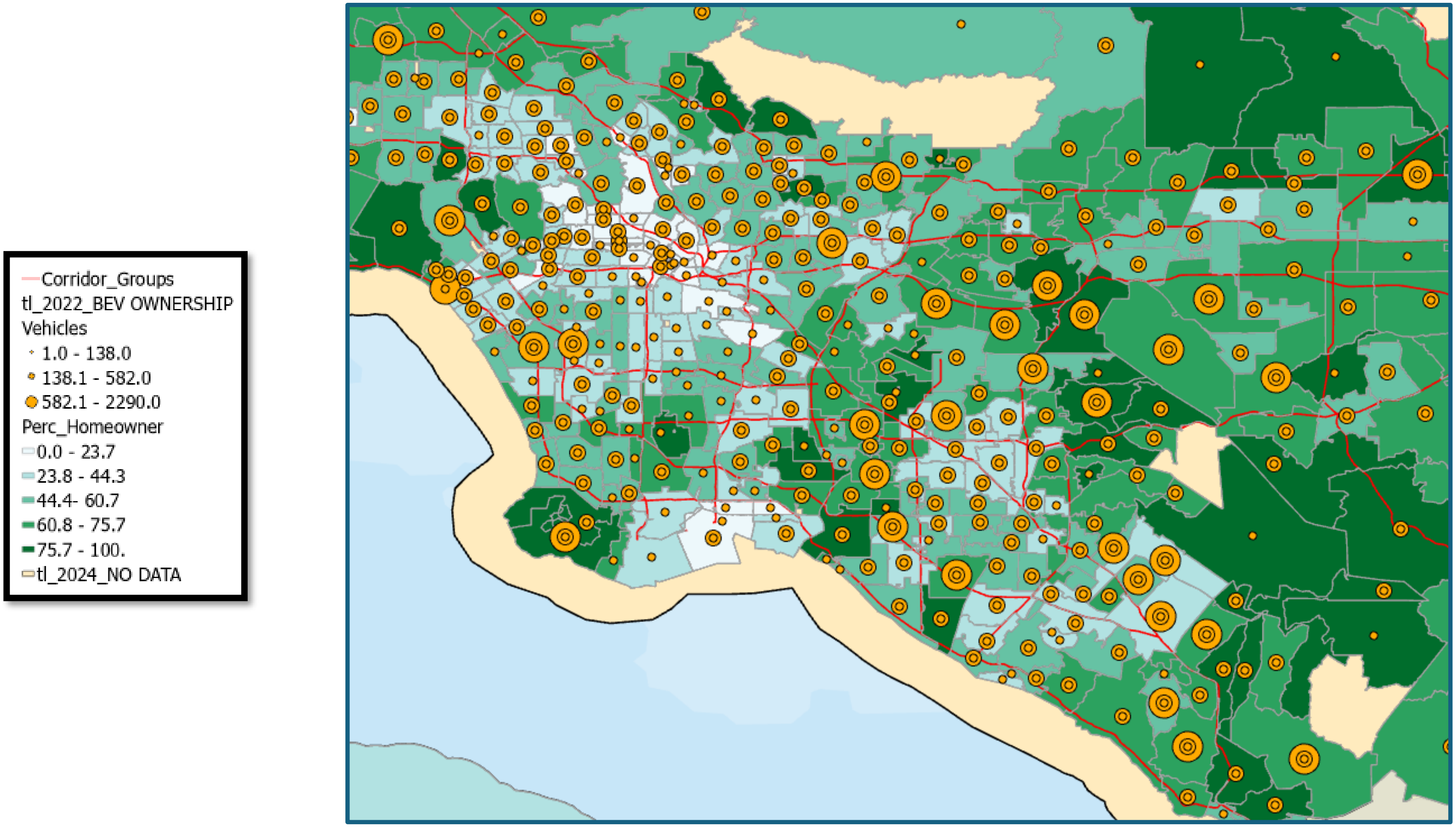

A strong inverse relationship exists between BEV ownership and population density within the SCAG region, particularly within areas of high population density in downtown Los Angeles, central Los Angeles, and Orange County. Few outliers are observed with this trend, even fewer than those observed for median annual income (Fig.2b) median household size (Fig. 3b) and minority populations (Fig.5b through Fig.7b). Therefore, population density appears to be a preceding factor in BEV ownership, suggesting being an even greater determinant per the findings of NRC et al., 2015

Fig. 9b BEV Ownership vs. Median Age



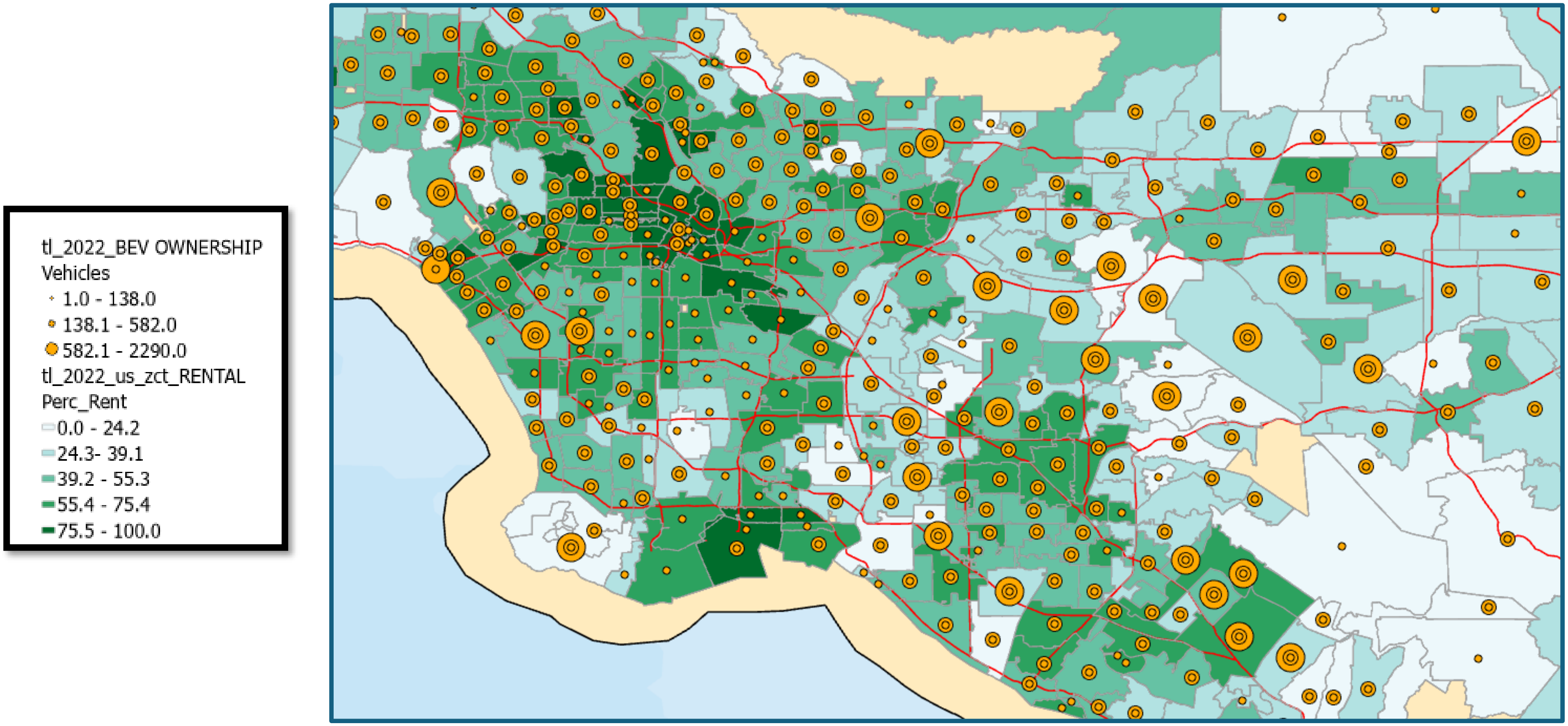

A proportional relationship exists between BEV ownership and median age. However, this relationship is largely restricted based on proximity to transportation corridors and proximity to urban areas. Thus, a normal distribution appears to exist relative to median annual income, where the majority of BEV owners reside in zip codes for peak earners (ages 36.0 to 52.5).

Fig. 10b BEV Ownership vs. Homeowner Population



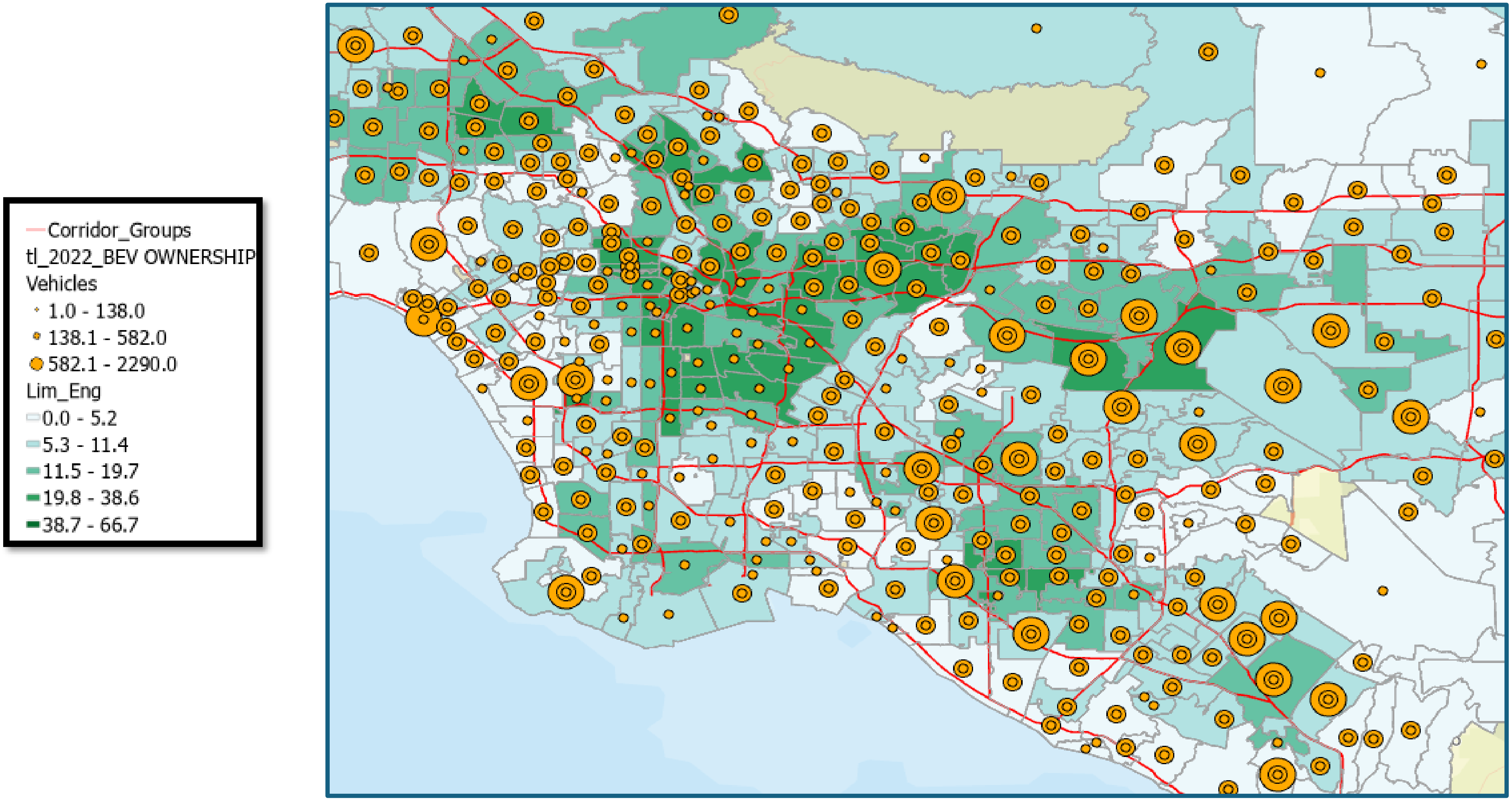

Similar to BEV ownership and population density (Fig. 7a), although a proportional relationship was observed between BEV ownership and homeowner population, this appeared to be restricted to areas within proximity to transportation corridors, given the presence of outliers in West Los Angeles and South Orange County. Thus, while not completely ruling out the role of homeowner population in impacting BEV ownership rates, site-specific findings within the SCAG region contradict the claims of ACS, 2022 when considering the presence of transportation infrastructure.

Fig. 11b BEV Ownership vs. Renter Population




Although a relatively inverse relationship was observed between BEV ownership and renter population, unlike that observed between BEV ownership and population density (Fig. 8a) and similar to that between BEV ownership and homeowner population, several outliers were observed within West Los Angeles and South Orange County, especially in proximity to transportation corridors. Thus, although the findings of ACS, 2022 and indirectly, NRC et al., 2015 true on a general scale, they fail to account for local variation, as consistently demonstrated by this spatial analysis.

Fig. 12b BEV Ownership vs. Limited English Proficiency




A strong inverse relationship exists between BEV ownership and limited English proficiency, affirming the findings of ACS, 2022. However, as previously noted for SCAG-considered variables, outliers to this trend exist along Hwy. 10 in East Los Angeles and West Riverside Counties.

### Summary

Similar to trends observed for SCAG-considered variables, the relationship between BEV ownership and ACS-considered variables also contained outliers. Noticeably, areas classified as non-urban (Fig.1b) overlapped with areas with high homeowner populations (Fig.10b), paralleling the findings of Hsu & Fingerman, 2021 and ACS, 2022 on the significance of land use in influencing charging station availability and thus, by extension, BEV ownership. Therefore, outliers observed for ACS-considered variables primarily comprised of deviations based on land use type, based on either population density (Fig.8b), rental population (Fig.11b), or homeowner population (Fig.10b). These outliers are primarily located within Eastern Los Angeles and South Orange County near transportation corridors.

A summary of outliers for ACS-considered variables is provided below:

1. **Zip code: 92602**

| **Jurisdiction(s)** | **Irvine** |
|---|---|
| Median Age | 36.1 |
| Homeowner Population | 43.2% |
| Renter Population | 56.8% |
| Limited English Proficiency | 7.94% |
| BEV: Charging Station Ratio | 210 |

2. **Zip Code: 92618**

| **Jurisdiction(s)** | **Irvine** |
|---|---|
| Median Age | 33.9 |
| Homeowner Population | 39.4% |
| Renter Population | 60.6% |
| Limited English Proficiency | 12.2% |
| BEV: Charging Station Ratio | 27 |

3. **Zip Code: 92782**

| **Jurisdiction(s)** | **Tustin** |
|---|---|
| Median Age | 39.6 |
| Homeowner Population | 60.6% |
| Renter Population | 39.4% |
| Limited English Proficiency | 5.45% |
| BEV: Charging Station Ratio | 138 |

4. **Zip Code: 90301**

| **Jurisdiction(s)** | **Inglewood** |
|---|---|
| Median Age | 37.6 |
| Homeowner Population | 25.7% |
| Renter Population | 74.3% |
| Limited English Proficiency | 8.07% |
| BEV: Charging Station Ratio | 266 |

5. **Zip Code: 90401**

| **Jurisdiction(s)** | **Santa Monica** |
|---|---|
| Median Age | 39.8 |
| Homeowner Population | 6.15% |
| Renter Population | 93.8% |
| Limited English Proficiency | 5.91% |
| BEV: Charging Station Ratio | 26 |

Unlike outliers cited for SCAG-considered variables, the majority of outliers contained within the parameters of ACS-considered variables varied based on land use features (e.g. access to transportation corridors) and resulting development patterns promoting higher-density development, and thus higher renter populations. As such, the outliers observed for ACS-considered variables appeared to be referenced under the "younger" EV market referred to in NRC et al.,2015, which analyzes the presence young professionals living in multifamily buildings as a growing share in BEV owners. This is in spite of older, suburban residents still comprising the majority (NRC et al., 2015), as noted in Fig.10b. Since a relatively small BEV_CS value was observed for these zip codes, indicating a greater presence of public charging station availability, efforts should thus be considered to expand BEV ownership in these areas given the presence of supporting infrastructure.

## 2. Charging Stations

Based on the charging station layer extracted from the CEC (CEC, 2024), a total of 7,956 stations were analyzed across the SCAG region. All of these save for three, were studied against SCAG-considered and ACS-considered variables.[3] A full list of SCAG-considered and ACS-considered variables is reiterated in Table 1c.

**Table 1c: SCAG-Considered Variables vs. ACS-Considered Variables**

| SCAG-Considered Variables | ACS-Considered Variables |
|---|---|
| Median Household Income | Median Age |
| Median Household Size | Homeowner Tenure (Homeowner vs. Renter) |
| Race/Ethnicity | English Language Proficiency |

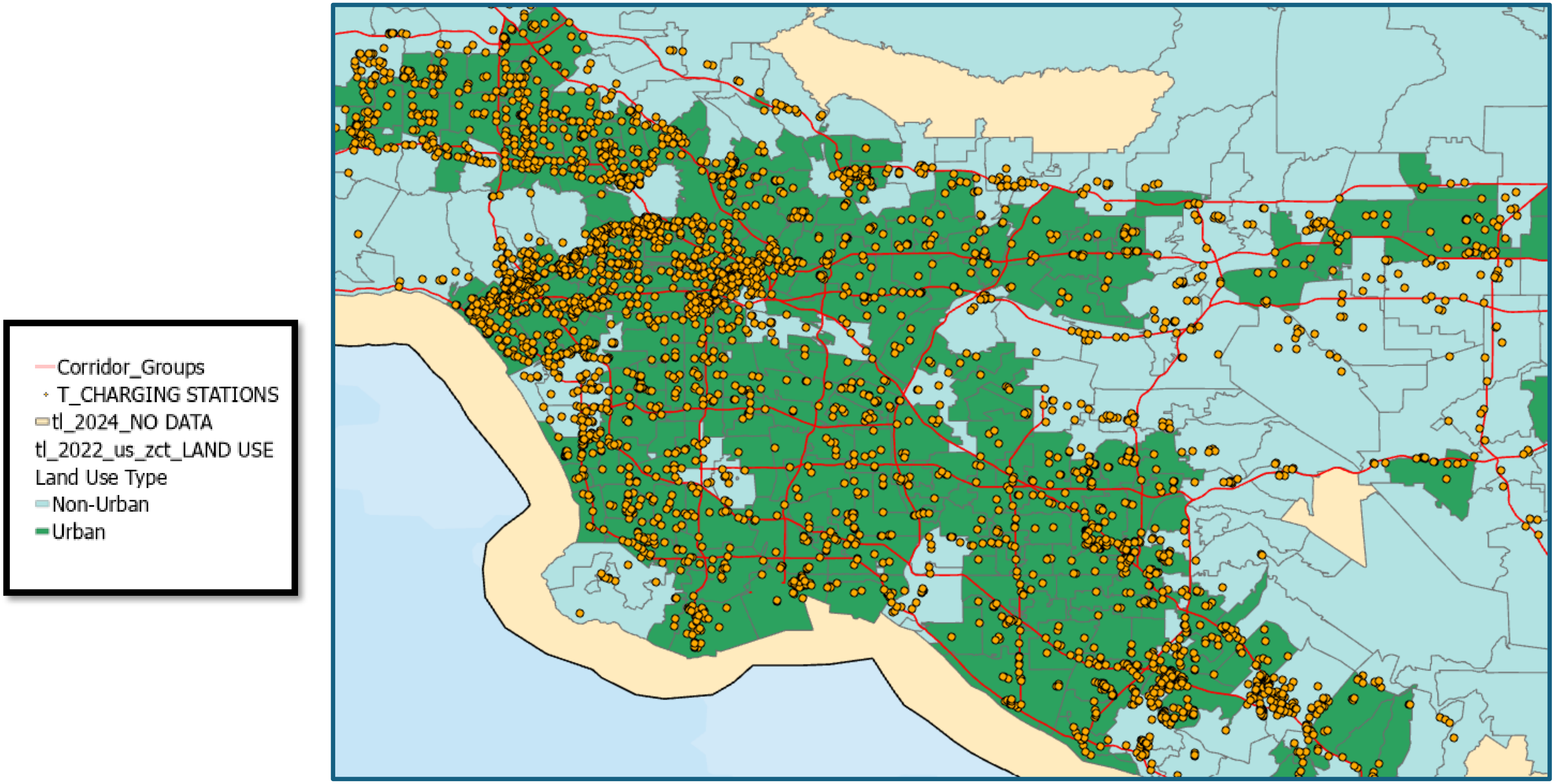
Similar to the spatial analysis conducted for BEV ownership, this analysis also considered land use contexts by considering urban- and nonurban-land uses (Fig. 1c) and population density (Fig. 8c) when studying public charging station distribution. Approximately 87% of BEV charging stations in the SCAG region are publicly accessible. (CEC, 2024) An analysis of the relationship between SCAG-considered variables and ACS-considered variables and public charging station distribution is provided below.

### *SCAG-Considered Variables*

SCAG-considered variables, or variables found to be significant in impacting BEV ownership in SCAG, 2024, were contextually examined against the distribution of publicly accessible charging stations. Reflecting analyses conducted for BEV Ownership, urban/non-urban land uses were initially studied with respect to public charging station distribution (Fig. 1c).

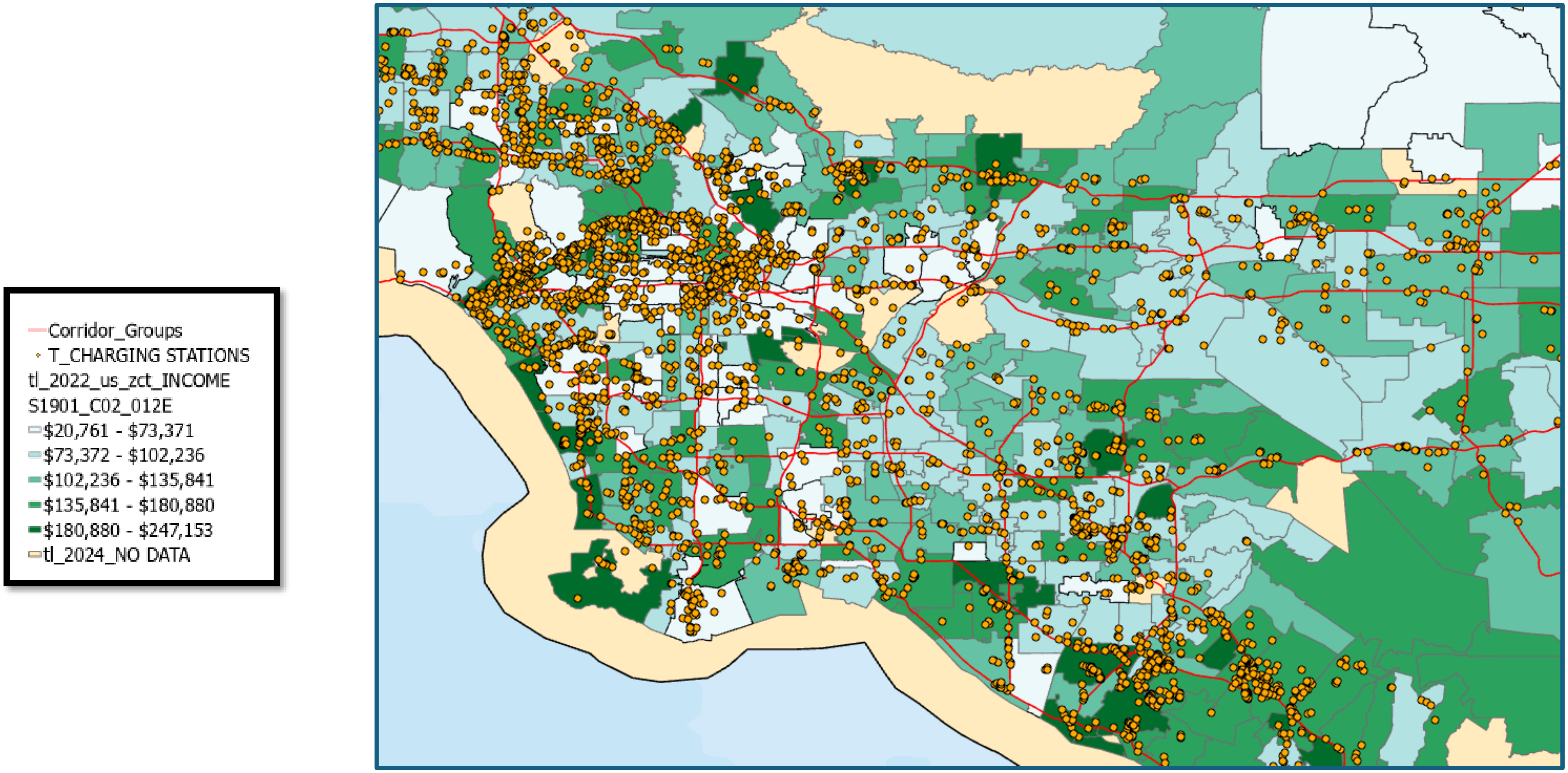
[3] These stations, located on the peripheral boundaries of the SCAG region, were unable to be factored into the join ACS layer to study socioeconomic distribution. (Nipton, Baker, Castaic) Based on the remoteness of these stations, it was determined that the inability to factor these charging stations would not significantly impact the results of this study.

Fig. 1c Distribution of Charging Stations vs. Land Use



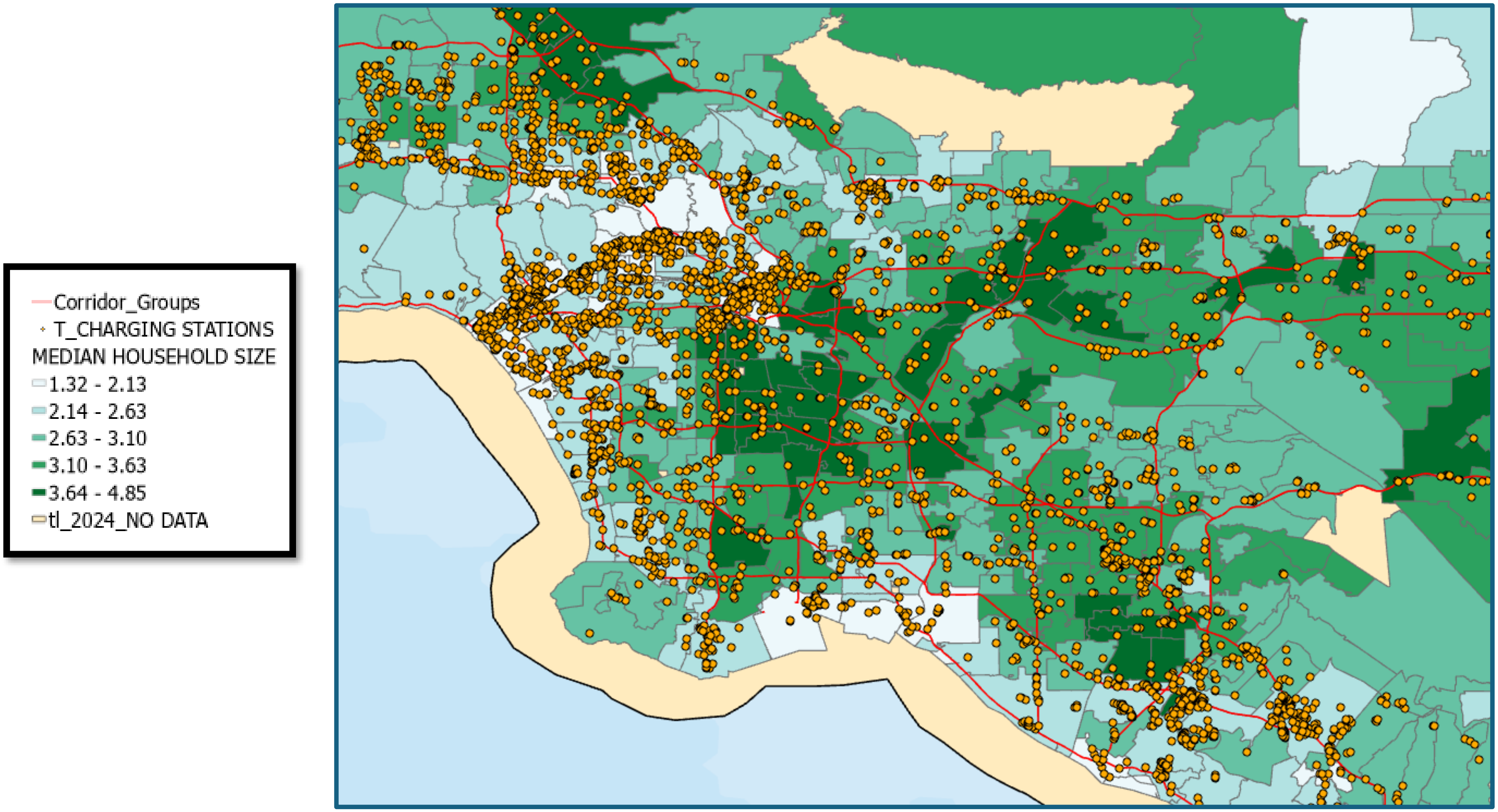

There is a higher concentration of publicly accessible charging stations within urban areas; this is in contrast for lower BEV ownership rates observed in these areas, per the findings of Fig.1b. Despite this, high rates of BEV ownership and high concentration of charging stations exist within South Orange County and West Los Angeles, similar to outliers observed for ACS-Considered Variables analyzed for BEV Ownership (Fig.9b to Fig.12b). Given the consistency of these outliers, an examination of local EV incentive programs is warranted (see3. EV Reimbursement Program Participation).

Fig. 2c Distribution of Charging Stations vs. Median Annual Income



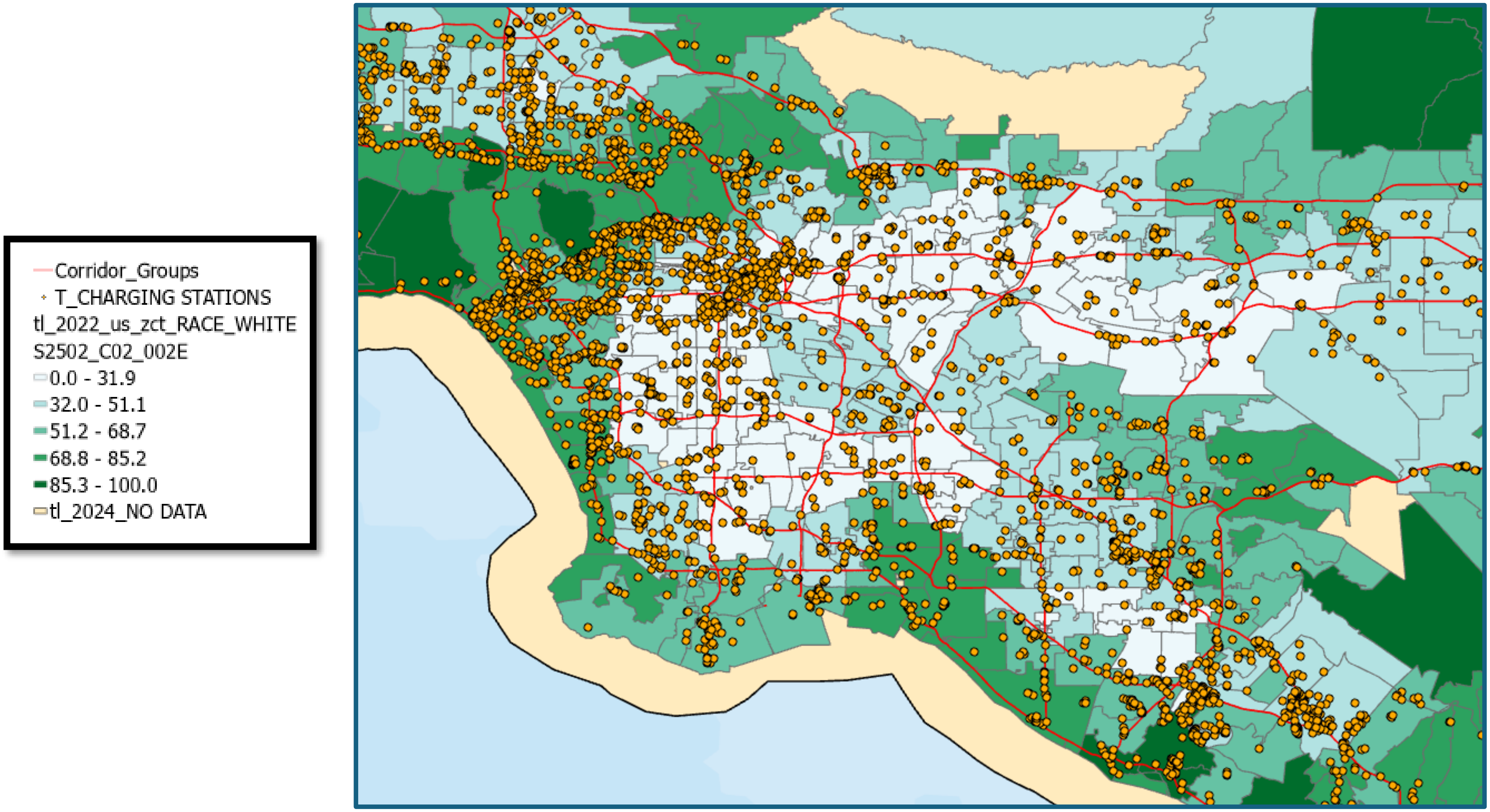

There is an inverse relationship between high median annual income areas and the public charging station distribution, with outliers overlapping with those found for urban/non-urban land use (Fig.1c) and ACS-considered variables analyzed with respect to BEV ownership (Fig.9b through Fig.12b).

Fig. 3c Distribution of Charging Stations vs. Median Household Size



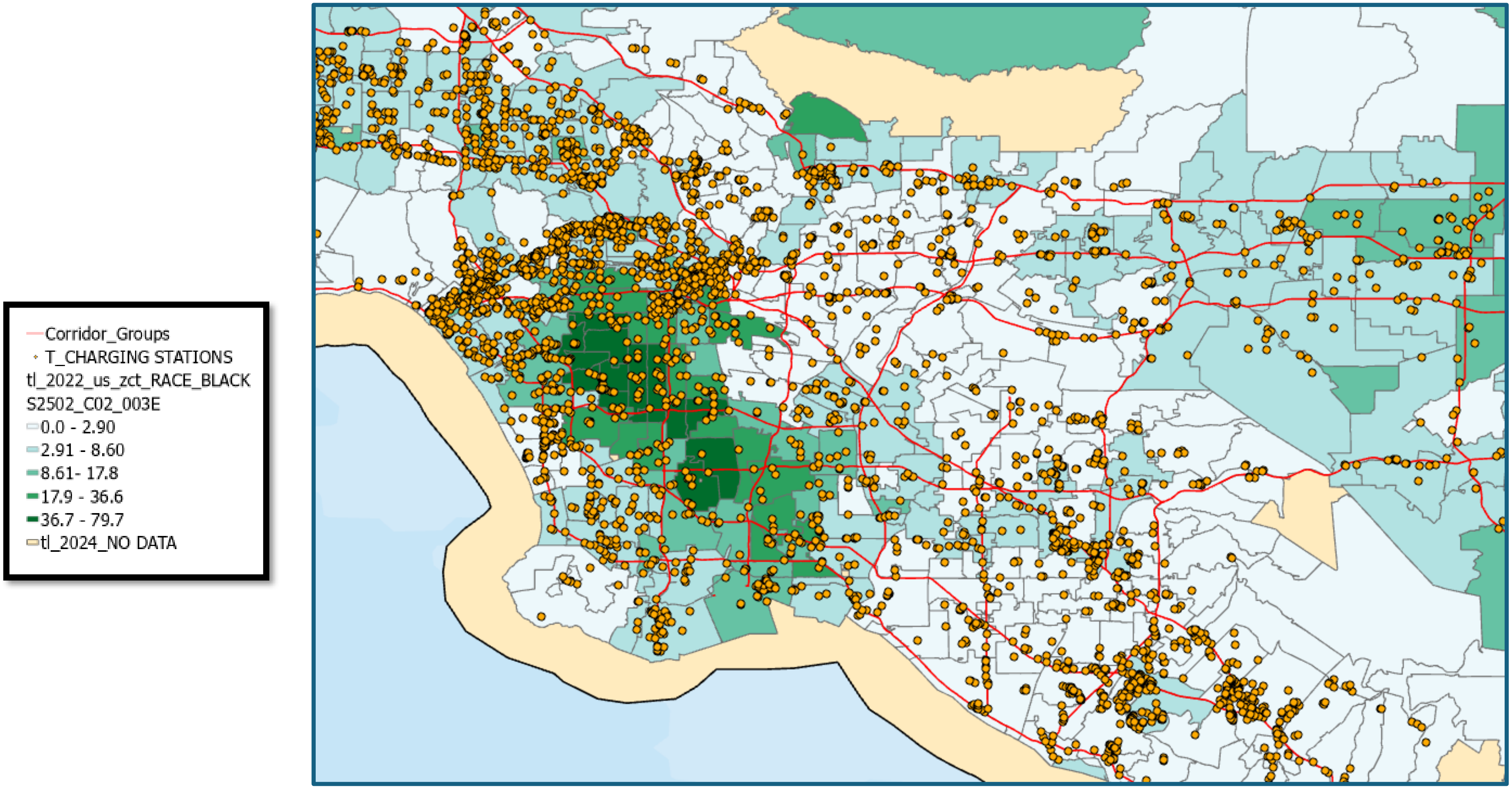

There is a strong inverse relationship between median household size the public charging station distribution; similarly to those observed for urban/non-urban land use and median annual income, outliers exist in south Orange County.

Fig. 4c Distribution of Charging Stations vs. White Population



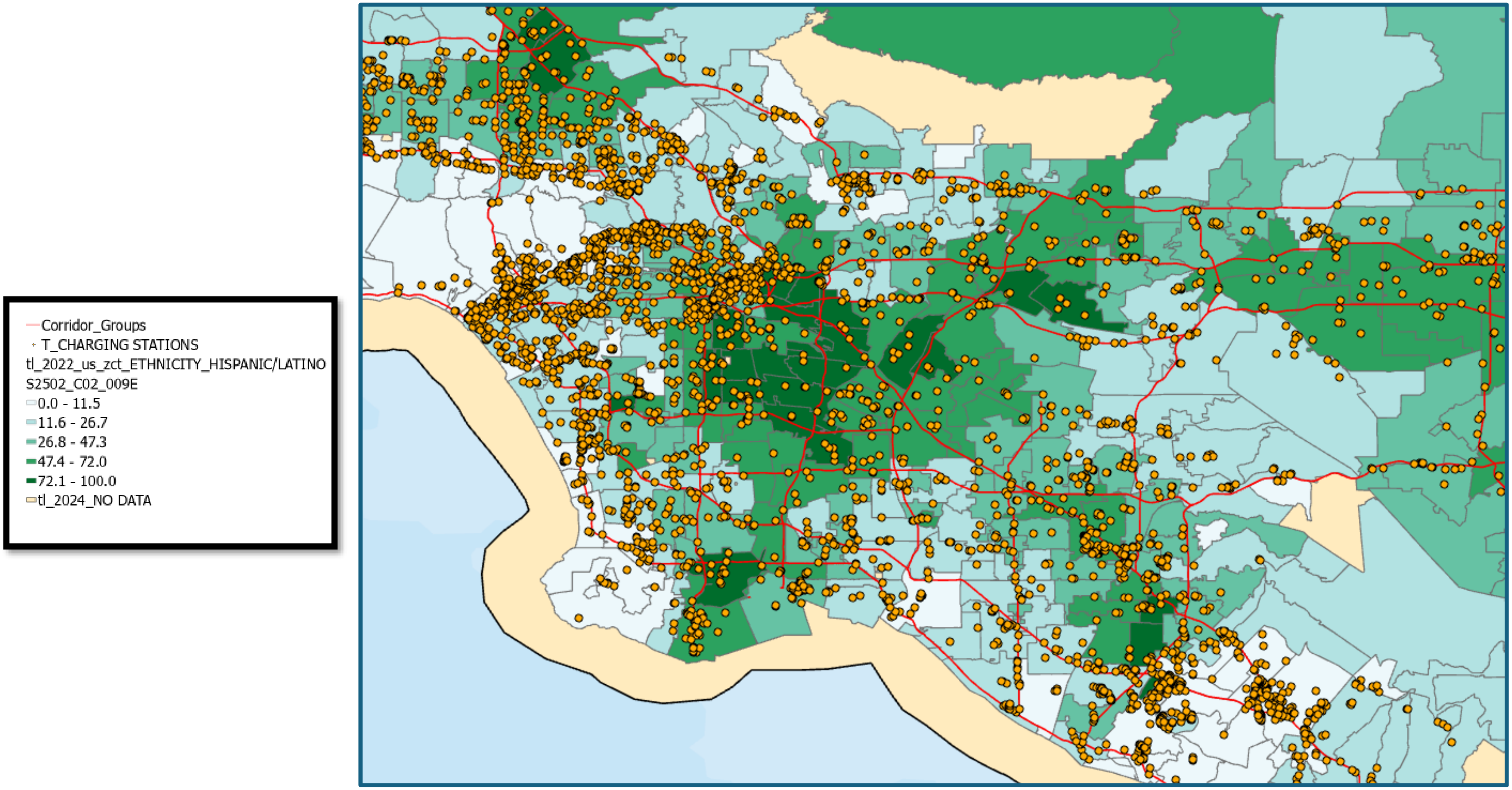

There is a proportional relationship between White population and public charging station distribution; taken with the proportionate relationship observed for between White population and BEV ownership, this affirms the findings of NRC et al., 2015 on the majority of BEV owners being white, of higher income status, residing in suburbia with access to home charging. Similar to that observed for median annual income (Fig.2c) and median household size (Fig.3c), however, South Orange remains an outlier to this trend.

Fig. 5c Distribution of Charging Stations vs. Black Population



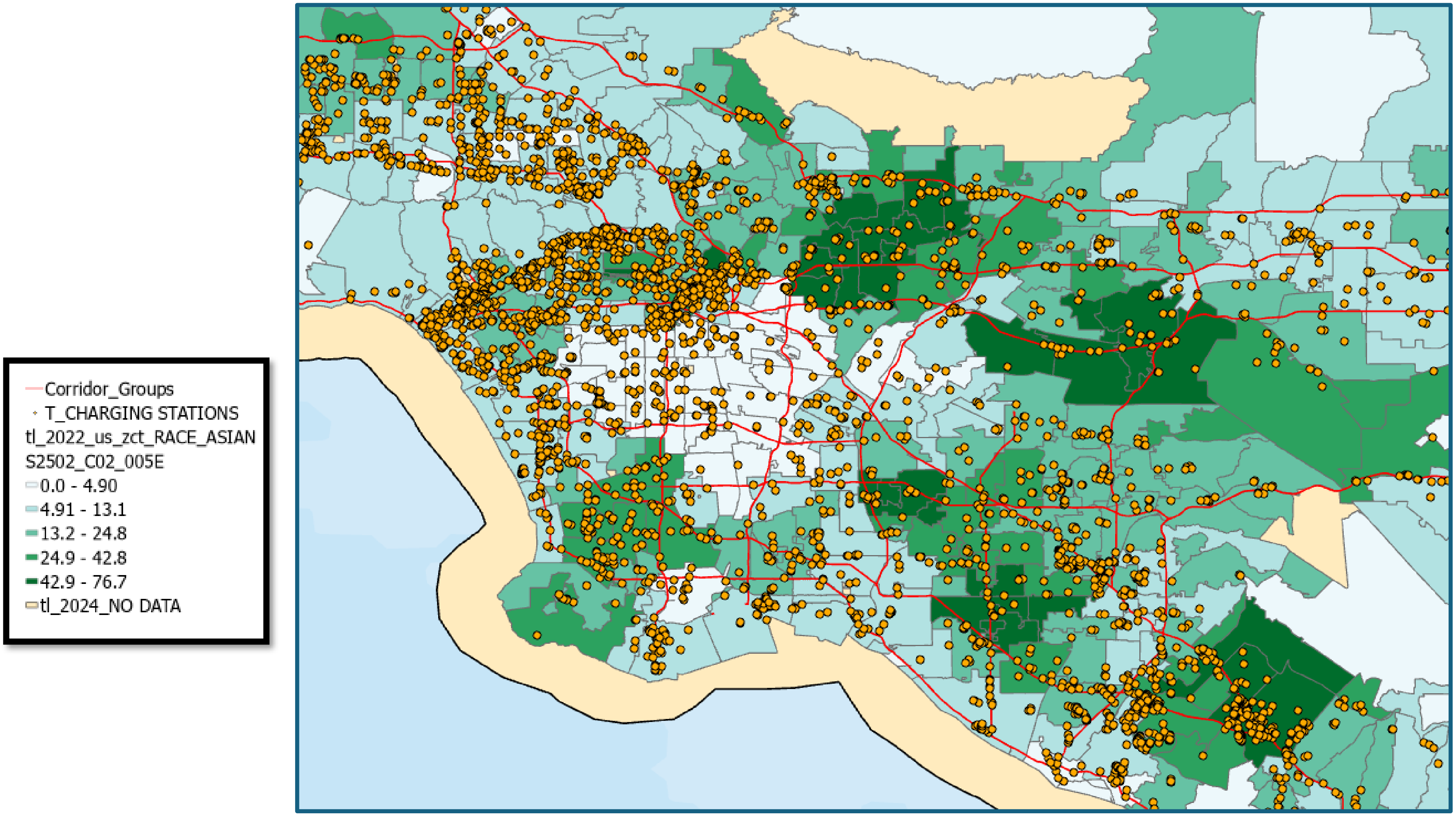

Despite the findings of Hsu & Fingerman, 2021, there is a fair degree of overlap between publicly accessible charging stations and Black zip codes, even when not in proximity to transportation corridors. However, as noted under the findings for BEV ownership (Fig.5b), this comes in contrast to low BEV ownership rates observed within these communities. Thus, disparities between BEV ownership rates and publicly accessible charging station access in these communities should be analyzed further.

Fig. 6c Distribution of Charging Stations vs. Hispanic/Latino Population




Per the findings of Hsu & Fingerman, 2021, a noticeable inverse relationship between publicly accessible charging stations and Hispanic/Latino population, with outliers in South Los Angeles and Central Orange County.

Fig. 7c Distribution of Charging Stations vs. Asian Population




Given the inconsistent relationship between public charging station clusters and zip codes with a high Asian population, there appears to be a non-significant relationship between public charging station distribution and Asian population.

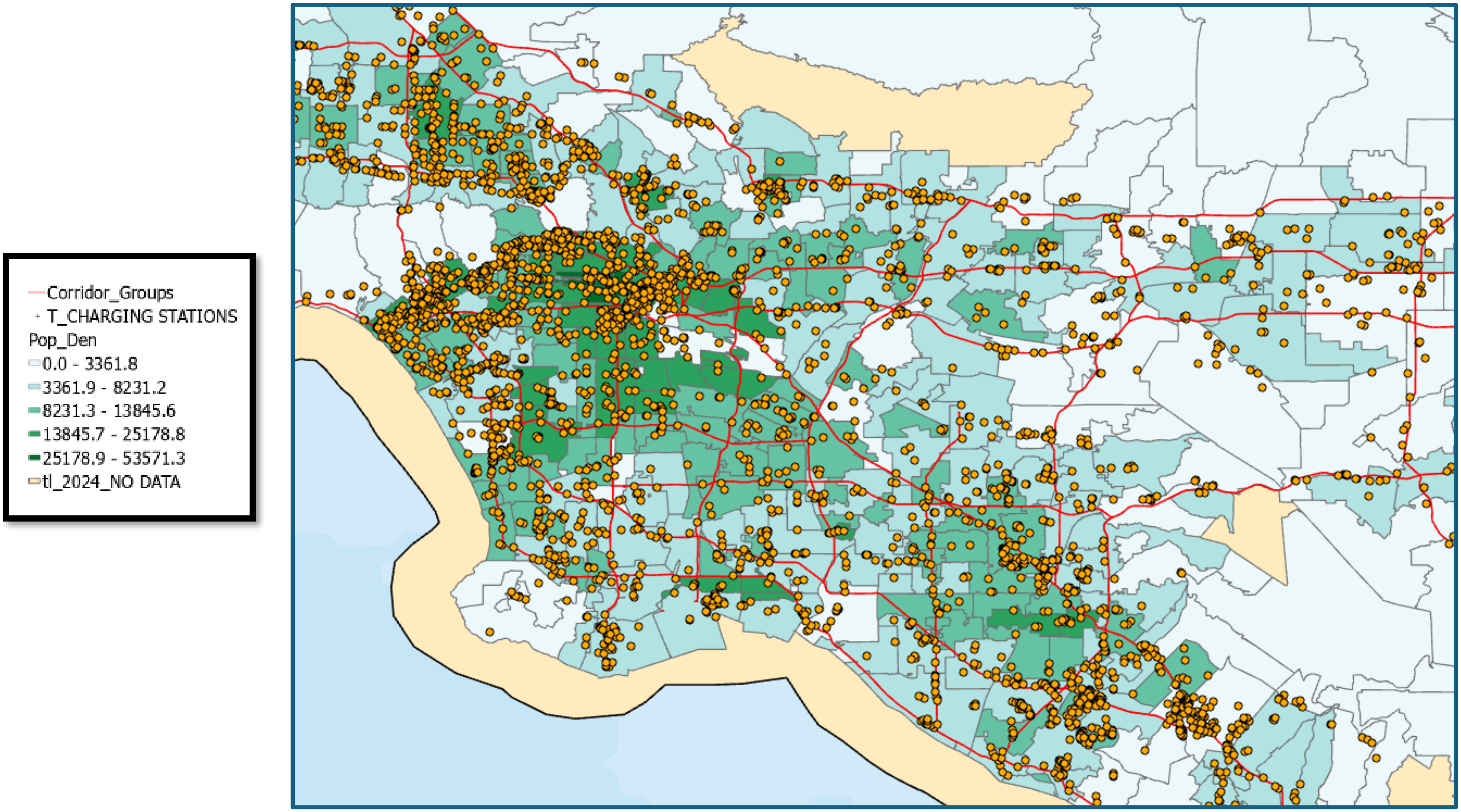
### Summary

Based on the findings of the spatial analysis, a high degree of overlap was observed between public charging station distribution and urban areas, public charging station distribution and transportation corridors, public charging station distribution and Black population. An inverse relationship was observed between public charging station distribution and median annual income, public charging station distribution and household size, public charging station distribution and white population, and public charging station distribution and Hispanic/Latino population. Findings between high public charging station distribution and zip codes of high Black population, as well as between outliers observed in South Los Angeles County and Central Orange County for Hispanic/Latino population, undermined the findings of Hsu & Fingerman, 2021 for disproportionately low public charging station distribution in those communities. However, a disparity between public charging station distribution and BEV ownership was also noted for those areas, according to the findings of Yu et al., 2023. Thus, this disparity is examined further under 3. EV Reimbursement Program Participation. Overall, few outliers were present, and those that were overlapped with outlier zip codes observed for ACS-considered variables as opposed to SCAG-considered variables under 1. BEV Ownership.

#### *ACS-Considered Variables*

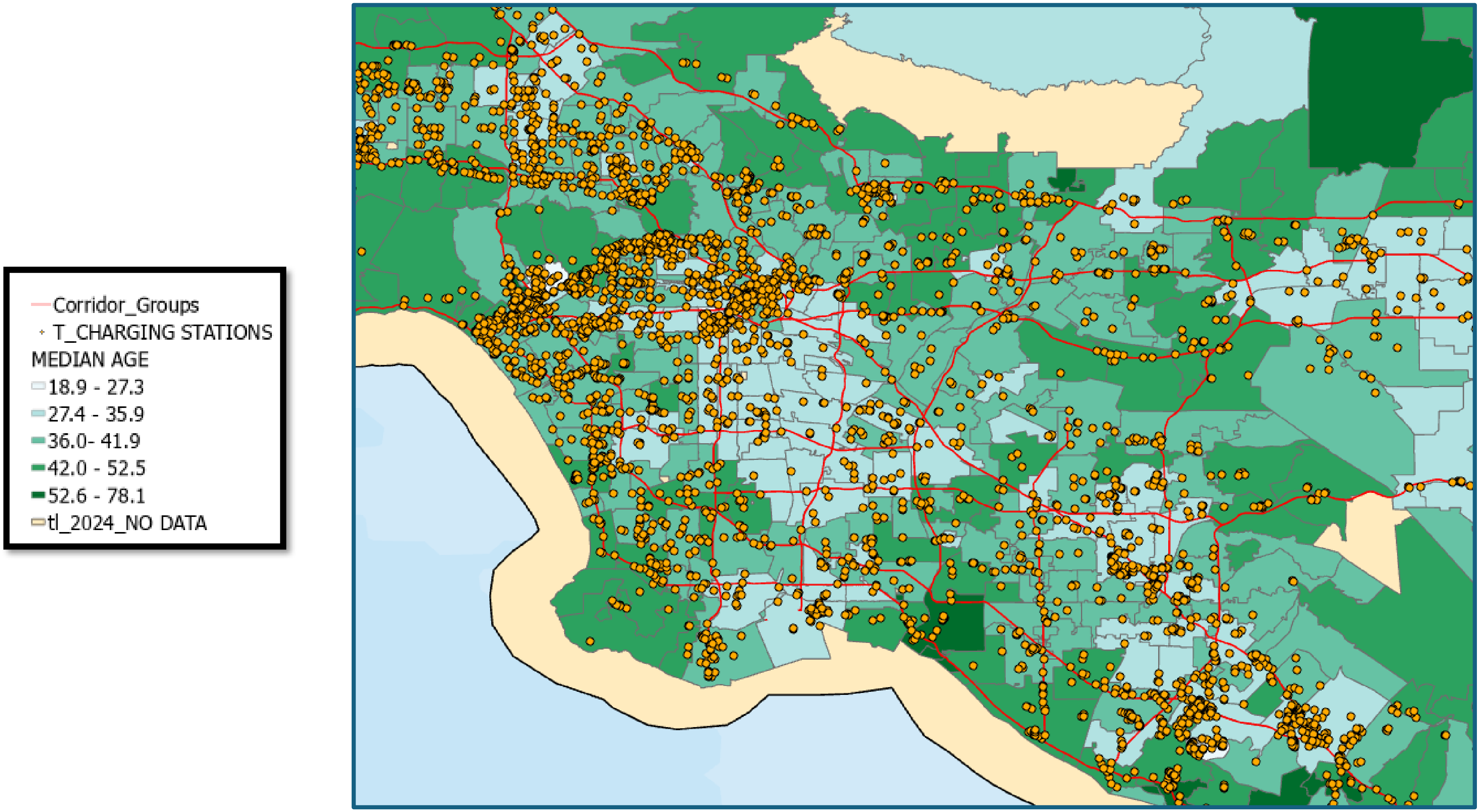
Following analysis of SCAG-considered variables, ACS-considered variables, or variables found to be significant in impacting BEV ownership in ACS, 2022, were also analyzed against the distribution of publicly accessible charging stations. Similar to the analysis conducted between ACS-considered variables and BEV ownership, population density was also examined in a spatial context (Fig. 8c).

Fig. 8c Distribution of Charging Stations vs. Population Density



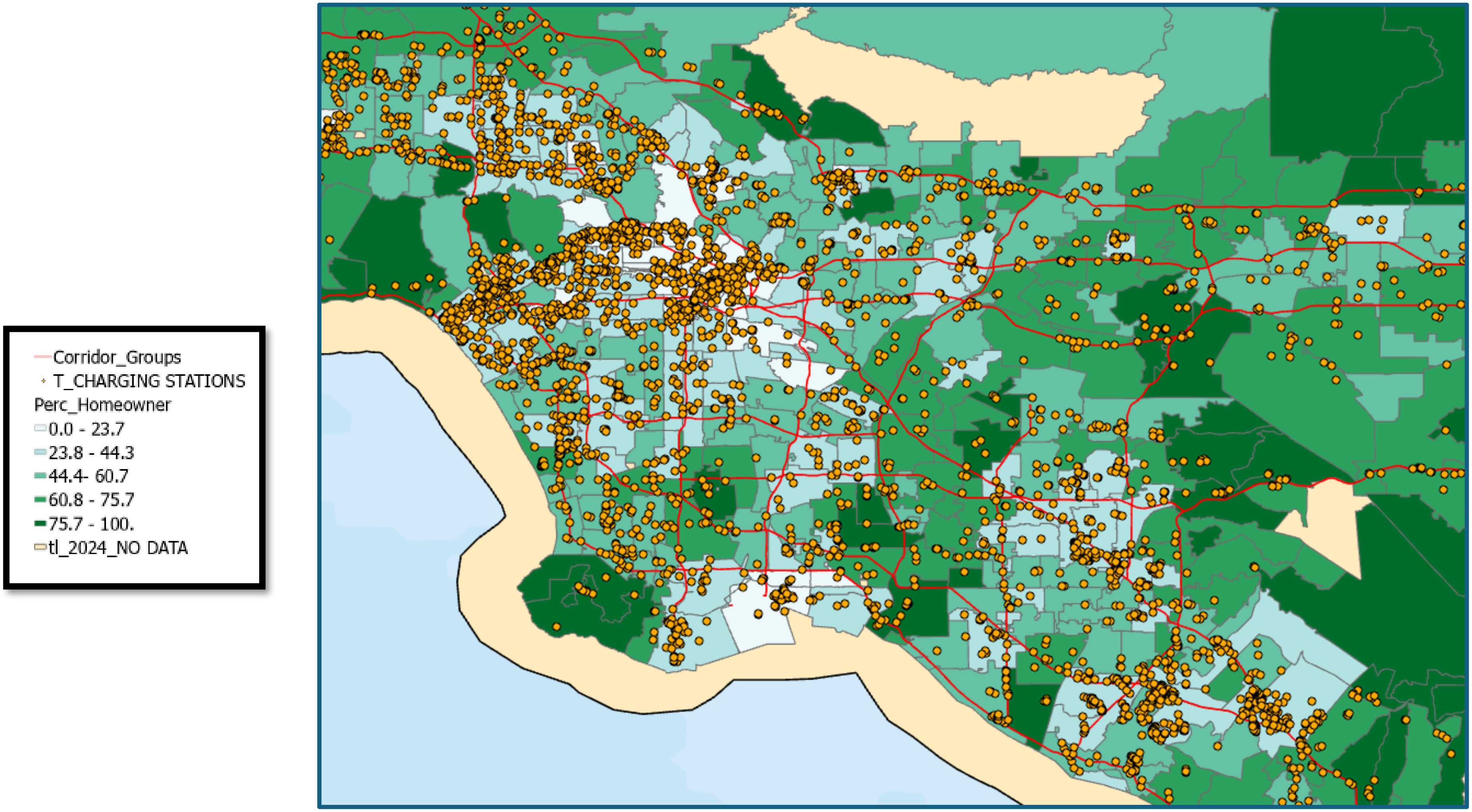

In contrast to a strong inverse relationship observed between BEV ownership and population density (Fig. 7c), the reverse held true for public charging station distributions and population density, with few outliers.

Fig. 9c Distribution of Charging Stations vs. Median Age



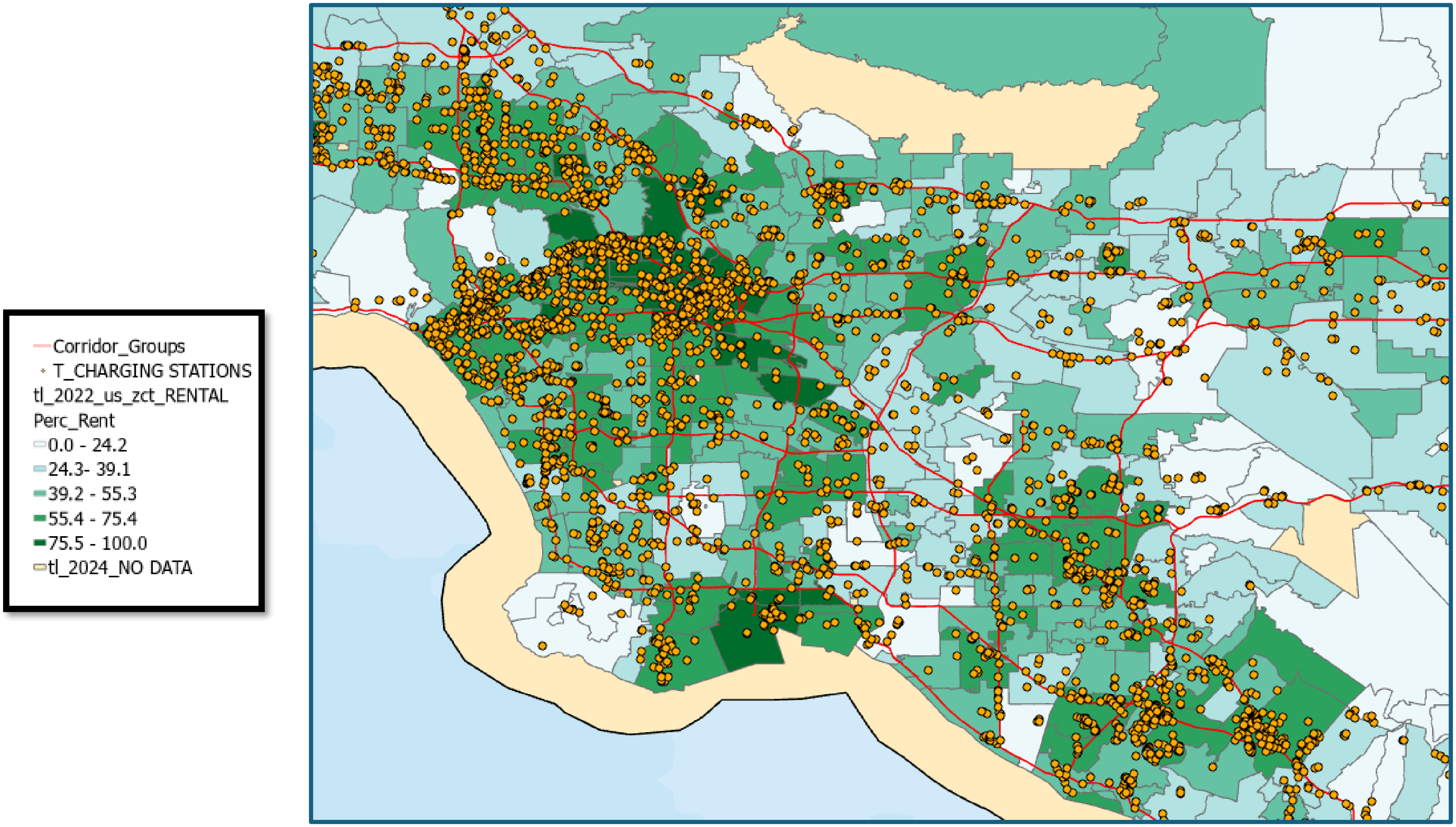

Similar to that observed for BEV ownership (Fig.9b), the relationship between public charging station distribution and median age resembles a normal distribution with peak overlap present for zip codes with high populations of peak earners (i.e. ages 36.0-52.5). Little to no outliers exist.

Fig. 10c Distribution of Charging Stations vs. Homeowner Population



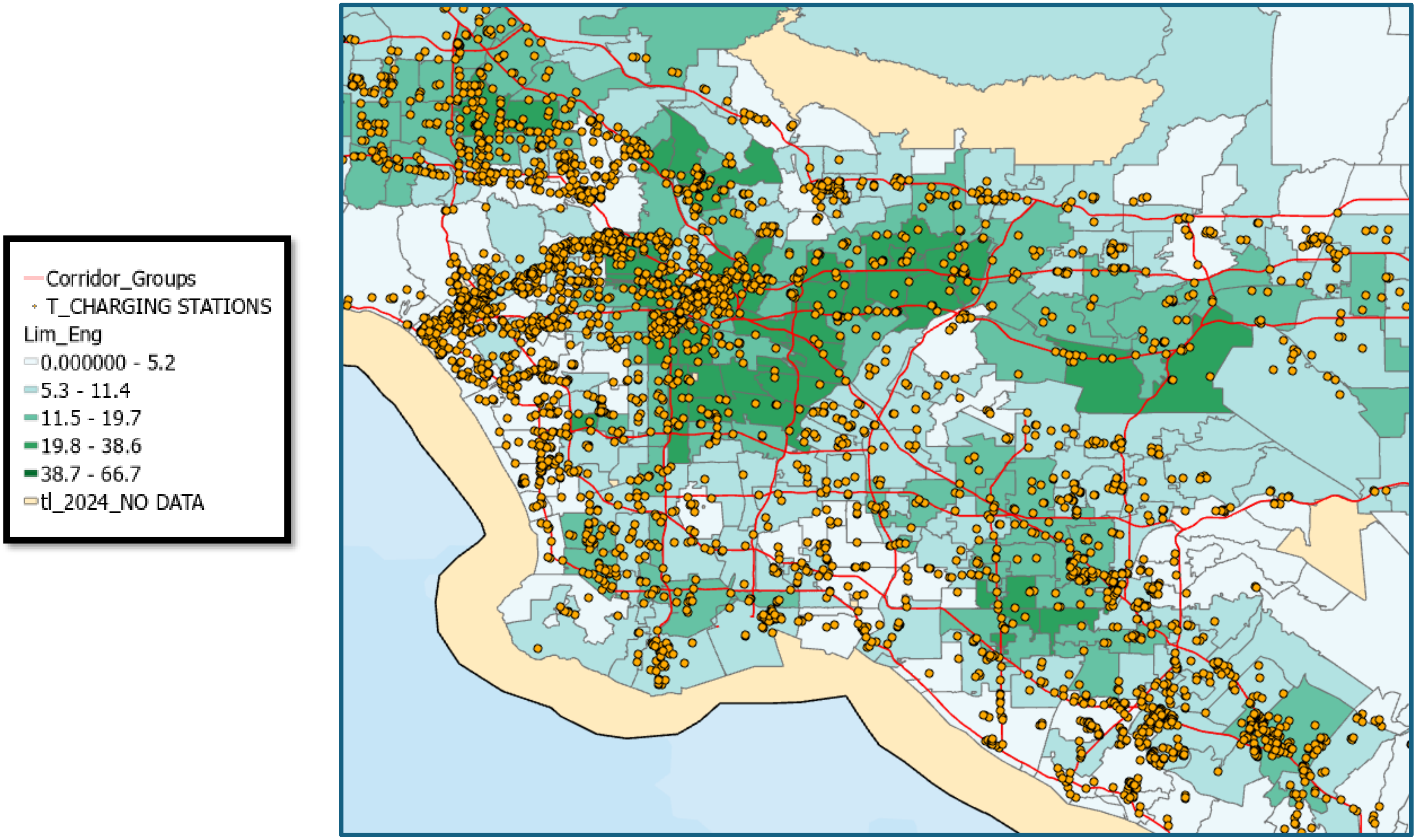

An inverse relationship exists between homeownership and public charging station distribution, with little to no outliers, further affirming the assumptions of NRC et al., 2015.

Fig. 11c Distribution of Charging Stations vs. Renter Population




In contrast to the inverse relationship observed BEV ownership and homeowner population (Fig.10c), the reverse holds true between public charging station distribution and renter population. Given the lack of BEV ownership observed within these zip codes (see Fig. 11b) disparities between public charging station access and BEV ownership rates exist.

Fig. 12c Distribution of Charging Stations vs. Limited English Proficiency




An inverse relationship exists between public charging station distribution and limited English proficiency, further paralleling the findings between BEV ownership and limited English proficiency (Fig.12b). However, several outliers exist, particularly within West Los Angeles County and downtown Los Angeles, contradicting the findings of ACS, 2022.

## Summary

Both the relationship between public charging station distribution and homeowner population and the relationship between public charging station distribution and renter population were the reverse of what was observed when analyzing BEV ownership rates with respect to these variables (Fig. 10b, Fig. 11b). These findings support the conclusions of NRC et al., 2015, which finds higher rates of residential charging amongst suburban BEV owners, further validating the findings of ACS, 2022 on the significance of these variables in determining BEV ownership. However, the conclusions of ACS, 2022 were indirectly challenged given the presence of a normal distribution observed between median age and public charging station distribution, with the highest concentration of charging stations observed in proximity to peak earners (ages 35.0-52.5) (Fig. 9c).

Another variable appearing to challenge the findings of ACS, 2022 was observed for that between charging station distribution and limited English proficiency. Although a general inverse trend was observed and few outliers were found to exist across most ACS-considered variables analyzed, several noticeable outliers were present when analyzing for Limited English Proficiency, particularly within West Los Angeles County and downtown Los Angeles. The characteristics of these outliers are described below.

1. **Zip code: 90012**

| **Jurisdiction(s)** | **Downtown Los Angeles (Central)** |
|---|---|
| Median Age | 35.2 |
| Homeowner Population | 6.4% |
| Renter Population | 93.6% |
| Limited English Proficiency | 27.1% |
| Dominant Language (%) | |
| #1 | Spanish (22.2%) |
| #2 | Other Indo-European Languages[4] (19.7%) |
| #3 | Vietnamese (18.7%) |
| #4 | Korean (18.5%) |
| BEV: Charging Station Ratio | 15 |

2. **Zip Code: 90007**

| **Jurisdiction(s)** | **Downtown Los Angeles (University Park)** |
|---|---|

[4] I.e. those not analyzed by the Census (Spanish, French, Germanic languages, Russian/Slavic languages) such as Armenian, Greek, and Celtic languages.

| | |
|---|---|
| Median Age | 25.2 |
| Homeowner Population | 10.6% |
| Renter Population | 89.4% |
| Limited English Proficiency | 23.3% |
| #1 | Spanish (76.8%) |
| #2 | Other Indo-European languages (6.7%) |
| #3 | Tagalog (6.0%) |
| #4 | Vietnamese (5.9%) |
| BEV: Charging Station Ratio | 3 |

3. **Zip Code: 91402**

| **Jurisdiction(s)** | **Los Angeles (Panorama City)** |
|---|---|
| Median Age | 34.4 |
| Homeowner Population | 35.9% |
| Renter Population | 65.1% |
| Limited English Proficiency | 23.0% |
| #1 | Spanish (71.6%) |
| #2 | Chinese (8.7%) |
| #3 | Russian, Polish, or other Slavic Languages (8.5%) |
| #4 | Vietnamese (2.7%) |
| BEV: Charging Station Ratio | 39 |

Within outliers for limited English proficiency, a noticeable degree of linguistic diversity was observed amongst English-limited households, particularly in downtown Los Angeles, where Tagalog, Slavic, and “Other” Indo-European languages were also present in addition to Spanish. Although SCAG already conducts significant outreach efforts for Limited English Populations (LEPs), in Spanish, Korean, Chinese, and Vietnamese, attention to less common languages in the SCAG region could also be beneficial, especially given the low BEV to Charging station ratio observed for these areas. (SCAG, 2022, 24)

### *Hot Spot Analysis Comparison*

To analyze the results of correlation between BEV charging stations and socioeconomic demographics, a hot spot analysis comparison was conducted. Through this, total similarity values were used to assess degree of association between charging station distribution and , or overlap, between both SCAG-considered and ACS-considered variables (including population density) and charging station distribution. Spatial fuzzy kappa values were used to assess the degree of association bias, or whether these associations occurred by chance.

Similarity values are analyzed on a scale of 0 to 1, with 0 being the lowest degree of overlap or probable association, and 1 being the highest. Spatial fuzzy kappa values are analyzed on a scale of -1 to 1, with -1 indicating negative association; 0 indicating no association; and 1 indicating strong positive association.

The results for the similarity values and spatial fuzzy kappa values for both SCAG-considered and ACS-considered variables are shown in Table 1d.

**Table 1d: SCAG-Considered Variables: Hot Spot Analysis**

| | **Total Similarity Value** | **Spatial Fuzzy Kappa Value** |
|---|---|---|
| | ***SCAG-Considered Variables*** | |
| Median Income | 0.6162 | 0.0500 |
| Median Household Size | 0.5987 | 0.0237 |
| Perc_White | 0.5699 | 0.0491 |
| Perc_Black | 0.6384 | 0.0873 |
| Perc_Asian | 0.6197 | 0.0588 |
| Perc_Hispanic/Latino | 0.5765 | -0.0146 |
| | ***ACS-Considered Variables*** | |
| Pop_Density (sq mi) | 0.6610 | 0.1327 |
| Median Age | 0.6060 | -0.0099 |
| Perc_Homeowner | 0.6106 | 0.0555 |
| Perc_Renter | 0.6417 | 0.0918 |
| Perc_Limited English Proficiency | 0.6363 | 0.0692 |

Both SCAG-considered and ACS-considered variables displayed moderate overlap with charging station distribution and very little association.

This was shown with the average total similarity value, or degree of overlap, ranging between 0.5765 to 0.6417; therefore, for all socioeconomic variables, charging station distributions were present in over half of zip codes for which socioeconomic information was available. For example, for zip codes in which population density data was available, approximately 64.17% of these zip codes contained at least one public charging station.

For spatial fuzzy kappa values, very little to no association was observed, with fuzzy kappa values ranging from -0.0146 to 0.1327. This indicates that very little significance, or clustering was present between charging station distribution and zip codes for which socioeconomic data was present. Thus, the distribution of charging stations for which socioeconomic data was randomized, or spread out, indicating very little to no association bias. For example, for zip codes in which population density data was available and at least one charging station present, approximately 13.27% of these zip codes reported significant clustering of charging stations.

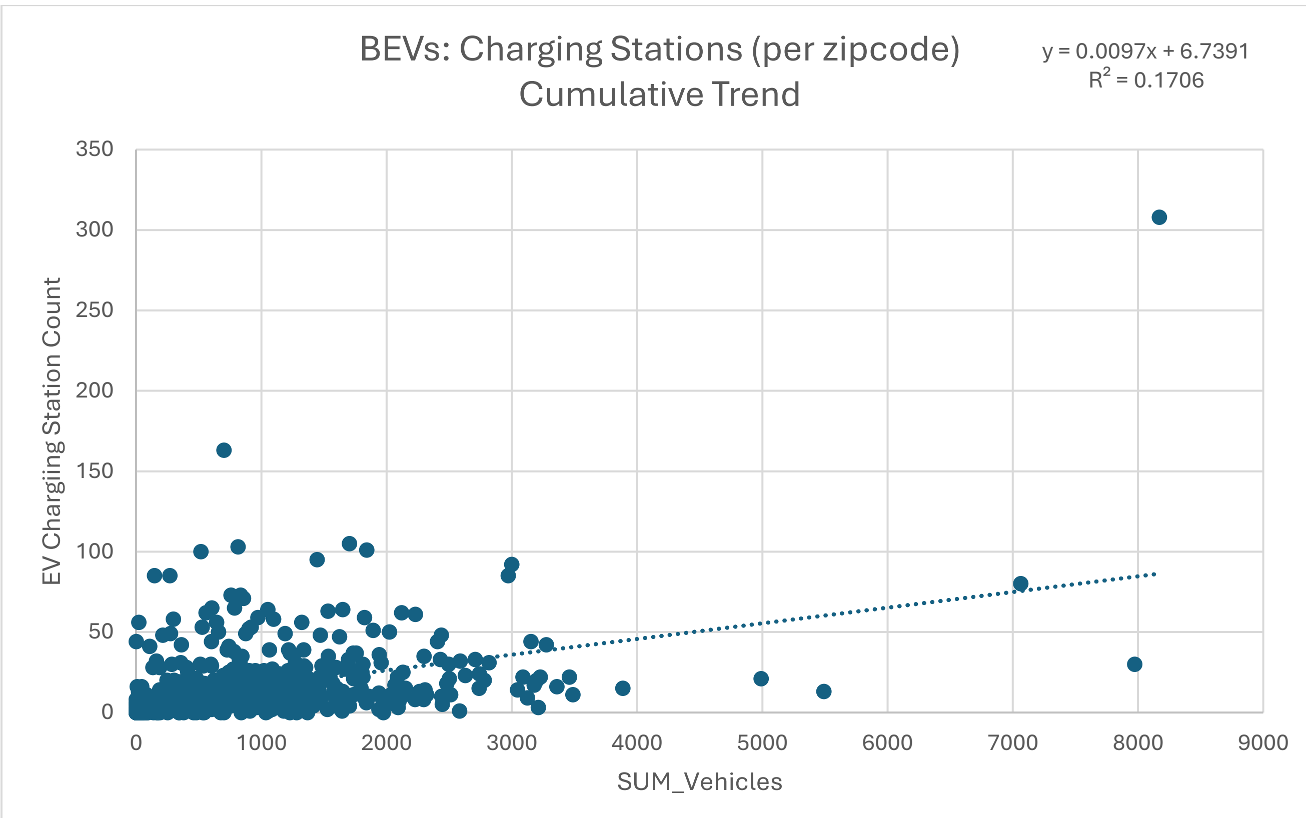
Similar to trends observed in the spatial analysis for public charging station distribution, results from the Hot Spot Analysis Comparison for Black population showed a moderately high similarity values (0.6384), as well as for Hispanic/Latino populations (0.5765), contradicting the findings of Hsu & Fingerman, 2021 by finding a moderately-high degree of overlap with public charging station distribution for all racial groups. Trends observed in the spatial analyses were also affirmed in the hot spots analysis comparison results for population density, which displayed the highest similarity value, or degree of overlap (0.6610), and the highest degree of association bias (0.1327) with respect to other socioeconomic variables. Per the observations made between population density and BEV ownership for the spatial analysis, this further promulgates the assumptions of land use being a precursor BEV ownership given the strength of this relationship to public charging station distribution relative to other socioeconomic variables.

### *BEV Ownership: Charging Station Distribution*

As previously mentioned, the number of registered BEVs to the number of publicly accessible charging stations was analyzed through applying the number of BEVs per publicly accessible charging station, or by the field BEV_CS, to zip codes for outliers when analyzing BEV ownership and public charging station distribution trends. Although the denominator of this field (# of BEVs/public charging station) indicates individual public charging stations, port availability, or the average number of ports per registered BEV, was also calculated to better frame the capacity of public charging stations in the SCAG region. When multiplying the average number of ports per public charging station by the overall number of public charging stations, and then using this to divide up the number of registered BEVs per zip code, it was found that the overall capacity of public charging station ports in the SCAG region, 8.92 BEVs per port or lower relative to the statewide average by approximately 21.6%. (CEC, 2024).

To study the ratio of registered BEVs to individual public charging stations, BEV_CS, across the SCAG region, Graph 1e is provided below:

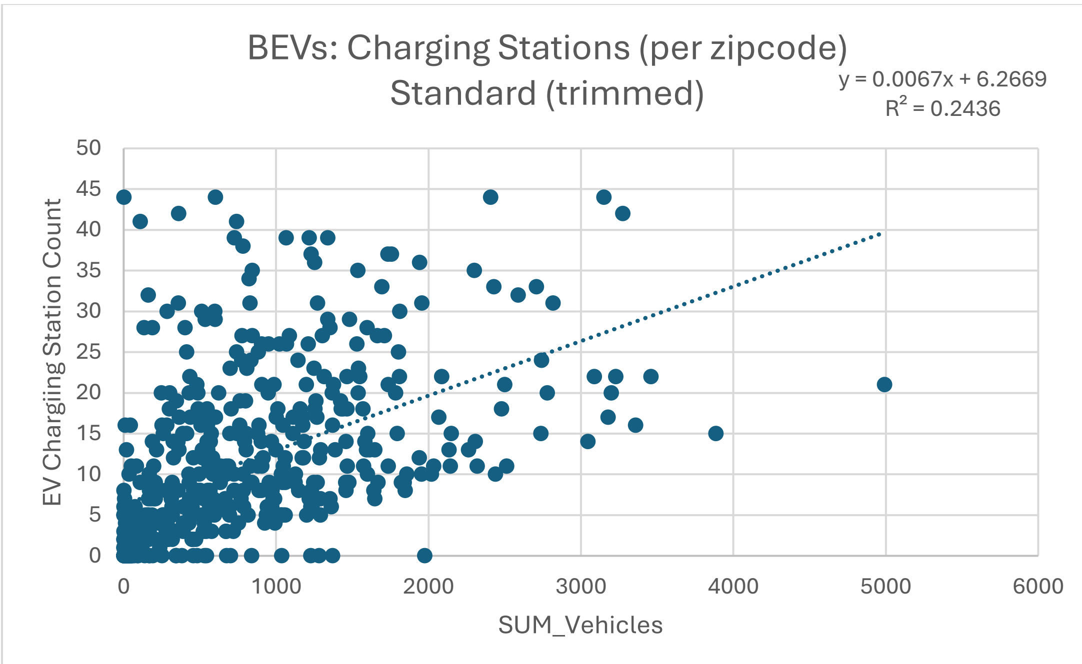
**Graph 1e: BEV: Charging Station Relationship Across Zip codes in the SCAG Region (Cumulative)**




The $R^2$ value, or correlation coefficient, illustrates the level of correlation between two variables, with -1 indicating negative correlation; 0 indicating no correlation; and 1 indicating perfect correlation.

The low $R^2$ value analyzed for the ratio of registered BEVs to Charging stations, therefore, was quite low, (0.1706), signifying minimal correlation. When trimmed for zip codes containing at least one registered BEV and one charging station (Graph 2e), a higher $R^2$ value was shown, but this value was also relatively low (0.2436), suggesting a modest correlation existing between BEV ownership and public charging station distribution at best.

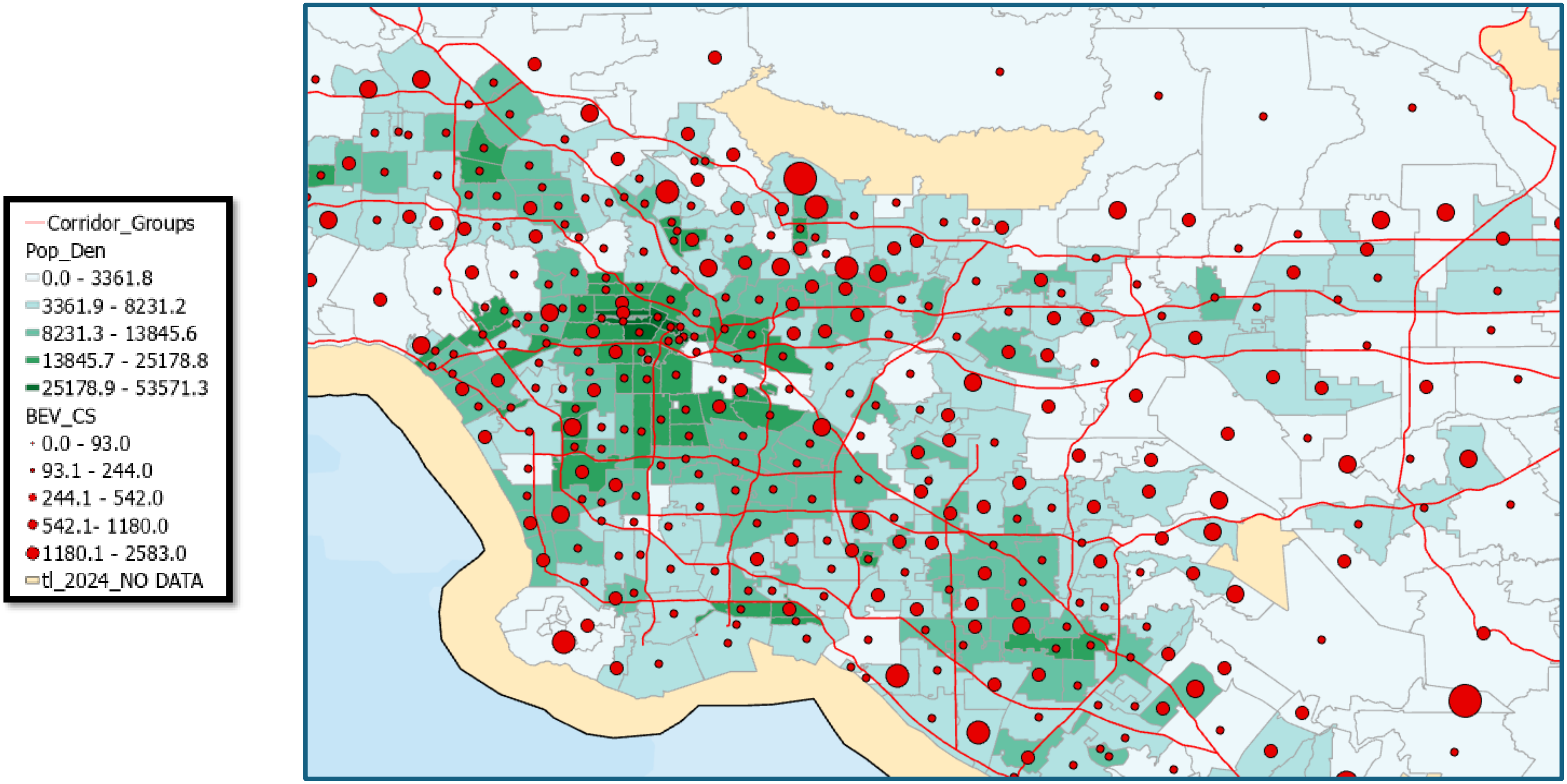
**Graph 2e: BEV: Charging Station Relationship Across Zip codes in the SCAG Region (Trimmed)**




To analyze variances in BEV_CS values across the SCAG region, Fig.1e is provided. Higher BEV_CS values indicate higher levels of BEV ownership (higher numerator) and lower public charging station distribution (lower denominator), and thus possible areas for BEV ownership expansion. Lower BEV_CS values indicate lower levels of BEV ownership (lower numerator) and higher levels of public charging station distribution (higher denominator), and thus possible areas for public charging station expansion.

Further down, Table 1e illustrates the top 20 zip codes with the highest BEV_CS values and Table 2e illustrates the bottom 20 zip codes with the lowest BEV_CS values. Towards the bottom of this section, Table 3e compares median socioeconomic characteristics between areas with high BEV_CS values, areas with low BEV_CS values, and the overall SCAG region.

Fig. 1e BEV Ownership: Charging Station Distribution Ratio with Respect to Population Density




As shown by the presence of low BEV_CS values in downtown Los Angeles and other heavily-urbanized areas, high population density is correlated with lower levels of BEV ownership, affirming the findings of NRC et al., 2015. These areas, by extension, suggest opportunities for BEV ownership expansion. However, several outliers, observed in West Los Angeles County and South Orange County, appear to contain higher pouplatino density and high levels of BEV ownership; therefore, these areas may be considered for public charging station expansion.

Table 1e: Top 20 BEV_CS Values (High BEV Ownership, Low Charging Station Distribution)

| Higher BEV Ownership & Low Charging Station Distribution (Top 20) | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Zipcode | City | County | Total Pop. | Pop_Den | BEV_CS | % White Pop. | % Black Pop. | % Asian Pop. | % Hispanic/Latino | % Homeowner | % Renter | Median Annual Income | Median Household Size | Median Age | % Limited English |
| 92679 | Trabuco Canyon | Orange | 30,971 | 1230.2 | 2583 | 79.5 | 1.7 | 9.9 | 12.1 | 89.6 | 10.4 | 107,159 | 2.97 | 45.0 | 1.2 |
| 91001 | Altadena | Los Angeles | 36,420 | 4409.2 | 1645 | 53.9 | 20.4 | 5.9 | 19.8 | 79.2 | 20.8 | | 2.89 | 44.5 | 2.5 |
| 91104 | Pasadena | Los Angeles | 35,918 | 9525.4 | 1180 | 54.5 | 7 | 10.3 | 30.6 | 54.0 | 46.0 | 78,513 | 2.66 | 41.2 | 11.4 |
| 90275 | Rancho Palos Verdes | Los Angeles | 41,941 | 3099.3 | 1071 | 59.2 | 1.3 | 30 | 8.2 | 79.8 | 20.2 | 206,013 | 2.69 | 49.8 | 6.4 |
| 91775 | San Gabriel | Los Angeles | 24,169 | 7798.0 | 1057 | 31.5 | 1.5 | 49.7 | 21.5 | 65.4 | 34.6 | 101,466 | 2.9 | 43.8 | 16.3 |
| 91381 | Stevenson Ranch | Los Angeles | 20,864 | 527.7 | 970 | 57.9 | 4 | 24.2 | 20 | 62.6 | 37.4 | 150,898 | 3.06 | 40.5 | 3.9 |
| 91202 | Glendale | Los Angeles | 22,831 | 4639.1 | 909 | 77.9 | 1.5 | 10.8 | 14.5 | 41.8 | 58.2 | 67,102 | 2.57 | 43.7 | 21.6 |
| 92649 | Huntington Beach | Orange | 35,206 | 6241.4 | 764 | 77.2 | 0.8 | 10.5 | 11.9 | 56.7 | 43.3 | 116,189 | 2.41 | 45.8 | 3.2 |
| 92646 | Huntington Beach | Orange | 56,033 | 6960.2 | 698 | 76 | 1.6 | 11 | 11.3 | 75.8 | 24.2 | 56,928 | 2.59 | 46.7 | 2.9 |
| 92629 | Dana Point | Orange | 26,144 | 5167.4 | 676 | 86.5 | 1.1 | 3.6 | 12.6 | 63.6 | 36.4 | 105,647 | 2.27 | 50.1 | 2.5 |
| 92688 | Rancho Santa Margarita | Orange | 44,444 | 3361.8 | 656 | 75 | 1.4 | 10.9 | 16.2 | 69.7 | 30.3 | 80,292 | 2.84 | 38.5 | 2.9 |
| 92532 | Lake Elsinore | Riverside | 27,454 | 1801.2 | 542 | 61.9 | 9.2 | 8.1 | 29.2 | 77.6 | 22.4 | 77,569 | 3.46 | 32.7 | 1.9 |
| 91387 | Canyon Country | Los Angeles | 46,812 | 876.3 | 540 | 57.4 | 7.6 | 8.8 | 36.2 | 64.2 | 35.8 | 127,416 | 3.34 | 34.7 | 4.9 |
| 92563 | Murrietta | Riverside | 78,139 | 3453.0 | 489 | 57.3 | 7.5 | 12.7 | 25.3 | 72.4 | 27.6 | 108,595 | 3.45 | 34.7 | 2.1 |
| 92869 | Orange | Orange | 36,429 | 2704.1 | 462 | 66.1 | 0.9 | 13.9 | 25.6 | 75.0 | 25.0 | 87,868 | 3.12 | 41.1 | 4.4 |
| 91737 | Rancho Cucomonga | San Bernardino | 23,108 | 2290.2 | 456 | 57 | 6.2 | 13.7 | 27.3 | 70.8 | 29.2 | 63,883 | 2.92 | 43.5 | 4.4 |
| 93063 | Simi Valley | Ventura | 57,075 | 1578.1 | 426 | 74.1 | 0.7 | 9.2 | 19.6 | 72.6 | 27.4 | 73,628 | 2.83 | 41.8 | 4.1 |
| 90402 | Santa Monica | Los Angeles | 11,816 | 5785.9 | 381 | 82.7 | 0.9 | 8.6 | 7.4 | 74.4 | 25.6 | 89,892 | 2.47 | 49.1 | 1.1 |
| 92808 | Anaheim | Orange | 21,080 | 4215.9 | 354 | 65.4 | 2.4 | 20.8 | 10.3 | 72.5 | 27.5 | 133,894 | 2.73 | 44.2 | 3.5 |
| 91745 | Hacienda Heights | Los Angeles | 55,489 | 4284.8 | 340 | 27.8 | 0.9 | 45.9 | 35.9 | 75.5 | 24.5 | 86,290 | 3.37 | 43.4 | 19.2 |

Table 2e: Bottom 20 BEV_CS Values (Low BEV Ownership, High Charging Station Distribution)

| Lower BEV Ownership & High Charging Station Distribution (Bottom 20) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Zipcode | City | County | Total Pop. | Pop_Den | BEV_CS | % White Pop. | % Black Pop. | % Asian Pop. | % Hispanic /Latino | % Homeowner | % Renter | Median Annual Income | Median Household Size | Median Age | % Limited English |
| 90089 | Los Angeles | Los Angeles | 4,164 | 12771.8 | 1 | 100 | 0 | 0 | 100 | 0.0 | 100.0 | | 2.17 | 19.6 | 0.0 |
| 92230 | Cabazon | Riverside | 2,039 | 174.6 | 1 | 61.3 | 0 | 0.8 | 40.1 | 81.2 | 18.8 | $ 64,024 | 2.81 | 41.5 | 3.5 |
| 92408 | San Bernardino | San Bernardino | 12,478 | 1191.0 | 2 | 39.9 | 8.4 | 16.7 | 54.8 | 39.6 | 60.4 | $ 87,719 | 3.25 | 34.2 | 16.7 |
| 90007 | Los Angeles | Los Angeles | 41,004 | 16873.2 | 3 | 30.3 | 11.2 | 18.1 | 52 | 10.6 | 89.4 | $ 49,182 | 2.86 | 25.2 | 23.3 |
| 92225 | Blythe | Riverside | 21,189 | 36.5 | 3 | 44.8 | 7.9 | 2.1 | 49.6 | 58.6 | 41.4 | $ 108,140 | 2.86 | 35.7 | 7.9 |
| 92311 | Barstow | San Bernardino | 34,226 | 80.6 | 3 | 52.1 | 11.3 | 2.6 | 46 | 47.1 | 52.9 | $ 63,072 | 2.83 | 32.4 | 2.9 |
| 90033 | Los Angeles | Los Angeles | 47,655 | 14541.4 | 4 | 19.7 | 2.9 | 6.9 | 85.9 | 19.7 | 80.3 | $ 79,304 | 3.47 | 31.8 | 24.9 |
| 91210 | Glendale | Los Angeles | 310 | 3247.0 | 4 | 87.8 | 0 | 12.2 | 18.3 | 18.3 | 81.7 | $ 145,643 | 1.89 | 48 | 22.0 |
| 90058 | Los Angeles | Los Angeles | 3,049 | 526.9 | 5 | 39.1 | 21.8 | 1.4 | 67.9 | 13.3 | 86.7 | $ 48,009 | 2.93 | 29.7 | 15.5 |
| 92617 | Irvine | Orange | 20,432 | 9147.2 | 5 | 46.9 | 5.7 | 33.5 | 14.5 | 30.1 | 69.9 | $ 142,614 | 2.71 | 20.9 | 5.3 |
| 92315 | Big Bear Lake | San Bernardino | 5,228 | 178.0 | 5 | 86.2 | 0 | 1.1 | 18.3 | 66.7 | 33.3 | $ 79,667 | 2.31 | 48.4 | 2.5 |
| 92410 | San Bernardino | San Bernardino | 48,398 | 5877.2 | 5 | 35.2 | 11.8 | 3.8 | 71.1 | 43.0 | 57.0 | $ 68,182 | 3.48 | 30.6 | 16.0 |
| 91502 | Burbank | Los Angeles | 12,312 | 9166.0 | 5 | 72.1 | 3.5 | 10.1 | 19.4 | 9.6 | 90.4 | $ 92,606 | 2.2 | 34.7 | 20.3 |
| 92866 | Orange | Orange | 14,873 | 7802.1 | 6 | 71.3 | 0 | 6.6 | 25.9 | 33.7 | 66.3 | $ 133,787 | 2.63 | 35.8 | 2.4 |
| 90021 | Los Angeles | Los Angeles | 2,781 | 1406.7 | 7 | 36.4 | 21.1 | 5.3 | 35.6 | 6.9 | 93.1 | $ 57,425 | 1.73 | 40 | 18.7 |
| 92518 | March Air Reserve Base | Riverside | 1,132 | 143.9 | 8 | 55.6 | 11.8 | 18.3 | 13.8 | 6.3 | 93.7 | $ 92,810 | 2.18 | 38.6 | 0.0 |
| 91746 | La Puente | Los Angeles | 29,429 | 5066.0 | 9 | 25.8 | 2.6 | 11.8 | 81.1 | 75.0 | 25.0 | $ 109,792 | 4.09 | 38.8 | 13.6 |
| 90067 | Los Angeles | Los Angeles | 2,653 | 6167.5 | 9 | 73 | 3.2 | 13.1 | 5.5 | 65.2 | 34.8 | $ 126,667 | 1.53 | 59.7 | 4.9 |
| 92868 | Orange | Orange | 27,280 | 7931.6 | 9 | 53.3 | 3.3 | 19.3 | 37.4 | 34.1 | 65.9 | $ 134,746 | 2.84 | 32.9 | 9.3 |
| 92832 | Fullerton | Orange | 26,040 | 8994.2 | 10 | 52.9 | 4.2 | 15.5 | 39.8 | 35.9 | 64.1 | $ 113,540 | 3.04 | 34 | 8.8 |

Table 3e. Median Socioeconomic Characteristics between High/Low BEV_CS Zip Codes

| Median SES Characteristics | | | |
|---|---|---|---|
| | **High BEV: CS (Top 20)** | **Low BEV: CS (Bottom 20)** | **County Median** |
| Total Population | 35,562 | 13,676 | 29,486 |
| Population Density (per sq. mi) | 3,834.5 | 5,471.6 | 3,837.1 |
| BEV: CS Value | 666 | 5 | 53.5 |
| % White Pop. | 63.7% | 52.5% | 69.55 |
| % Black Pop. | 1.6% | 3.85% | 1.40% |
| % Asian Pop. | 10.9% | 8.5% | 4.4% |
| % Hisp./Latino | 19.7% | 40.0% | 17.9 |
| % Homeowner | 72.5% | 33.9% | 59.0 |
| % Renter | 27.5% | 66.1% | 41.0 |
| Median Household Size | 2.87 | 2.82 | 2.84 |
| Median Household Income | $89,892 | $92,606 | $87,125 |
| Median Age | 43.6 | 34.5 | 38.3 |

Contrary to the findings of Hsu & Fingerman, 2021 and Yu et al., 2023, median income did not appear to differ significantly between areas of high BEV_CS values (i.e. high BEV ownership) and areas of low BEV_CS values (i.e. low BEV ownership). As mentioned previously, outliers consisting of high BEV ownership and low to moderate income-status were observed within non-urban areas, such as San Bernardino and West Riverside counties (Fig.2b), or areas noted to have high degrees of homeownership (see "Summary" for ACS-Considered Variables under the spatial analysis conducted for BEV Ownership). Thus, given the significantly higher degree of homeownership amongst zip codes with high BEV_CS values, indicating higher levels of BEV ownership, as opposed to those with low BEV_CS values, indicating lower levels of BEV ownership, and the county as a whole, it can be concluded that home tenure is a significant factor impacting BEV ownership, supporting the findings of Hsu & Fingerman, 2021 and ACS, 2022. This is also observed when noting the presence of low renter populations within areas of high BEV_CS values, indicating high levels of BEV ownership, and high renter populations within areas with low BEV_CS values, or areas of low BEV ownership. The significance of these variables is indicated by population density as a metric where, consistent with the conclusions of NRC et al., 2015, highly populated areas contained low BEV_CS values indicating low BEV ownership and less-populated areas contained high BEV_CS values indicating higher BEV ownership. Furthermore, given that the greatest disparities observed between high BEV_CS zip codes, low BEV_CS zip codes, and the SCAG region were not based on SCAG-considered variables such as median income and median household size but rather land use-adjacent variables such as population density, and those referred to under ACS, 2022 , it can be concluded that factors related to land use may influence BEV ownership and public charging station distribution to a greater degree than other socioeconomic variables analyzed.

However, contrary to the findings of Hsu & Fingerman, 2021, there are higher Black and Hispanic/Latino populations in areas of high public charging station density, or areas indicated by low BEV_CS values, affirming the results of the hot spot analysis comparison and, for at least Black populations, the spatial analysis.  This is countered by the presence of low BEV ownership rates for these variables (Fig. 5b, Fig. 6b), which as noted by Yu et al., 2023, experience worsened air quality as a result of low BEV ownership rates. Thus, for socioenvironmental considerations, prioritized BEV ownership expansion for these areas (see Table 3e) should be considered for these reasons. Finally, although a higher Black population was observed with high BEV_CS areas, or zip codes with higher rates of BEV ownership than the SCAG region as a whole, it should be noted that the majority of the SCAG region's Black population (see Fig.5b and Fig.5c) is concentrated within south and central Los Angeles. Given this high clustering and adjacency to zip codes with higher rates of BEV ownership, it is thus not surprising that a slightly higher percentage of the region's Black population would occur in urban areas of higher rates of BEV ownership than rural areas with lower BEV ownership. Thus, the geographic distribution of racial populations should also be considered when formulating policy recommendations from this analysis.

## 3. EV Reimbursement Program Participation

Based on data extracted from Center for Energy Sustainability, 2024, participation rates were analyzed across the SCAG region indicated highest participation in the CVRP occurring within Los Angeles County (54.5%), with highest participation for vehicle type occurring from BEV owners (67.2%). In accordance with the findings of Connelly et al., 2024, the vast majority of CVRP participants in the SCAG region were from non-DAC/LIC communities (70.1%).

Based on data extracted from Center for Energy Sustainability, 2024, participation rates were analyzed across the SCAG region indicated highest participation in the CVRP occurring within Los Angeles County (54.5%) (Chart 1f), with highest participation based on vehicle type occurring amongst BEV owners (67.2%) (Chart 2f). A full breakdown of DAC/LIC participation rates by county is provided in Chart 3f and Table 1f and subsequently weighted in Table 2f. The breakdown of Non-DAC/LIC participation rates is also provided in Table 3f, below.

**Chart.1f CVRP Participation by County (All Vehicle Types)**

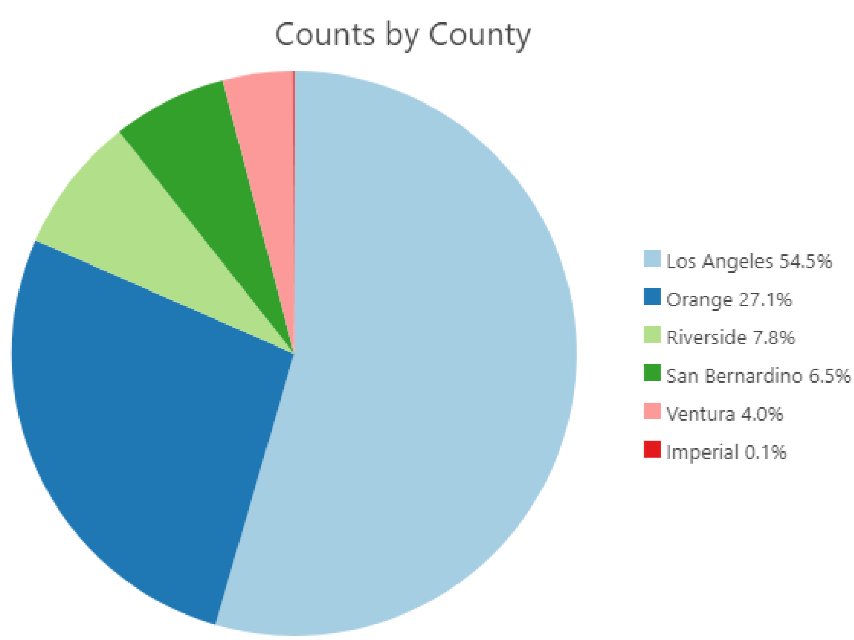


**Chart.2f CVRP Participation by County (BEVs**

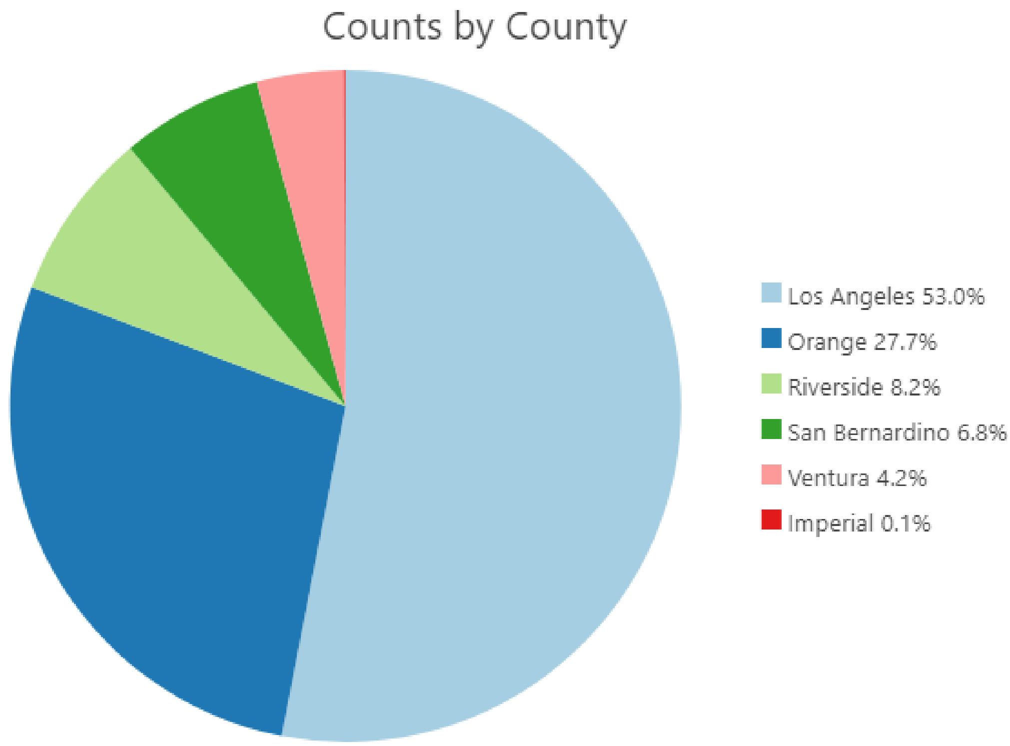



**Chart.3f DAC/LIC Participation by County (BEVs)**

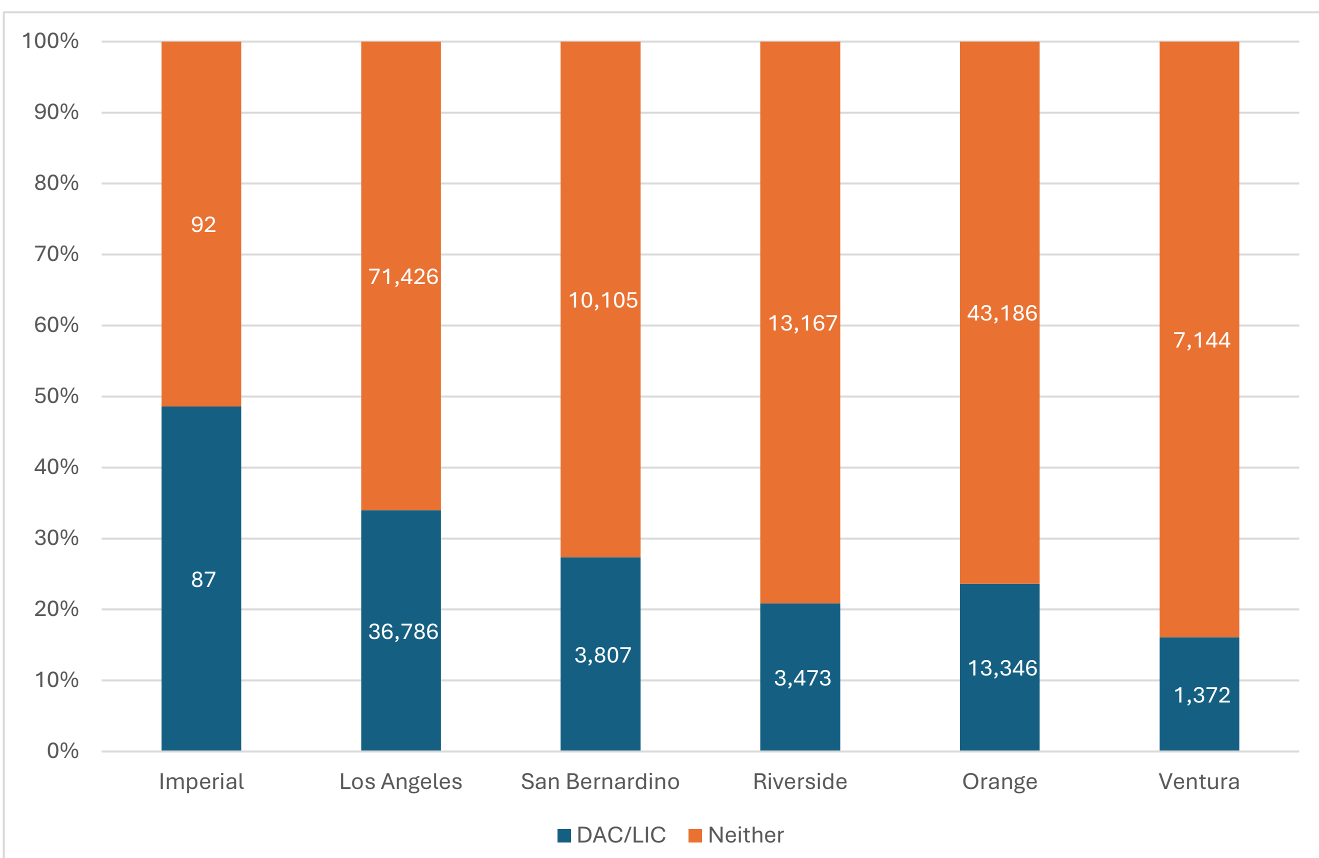


**Table.1f DAC/LIC Participation by County (BEVs)**

| | DAC/LIC (#) | % | Neither (#) | % |
|---|---|---|---|---|
| **Imperial** | 87 | 48.6 | 92 | 51.4 |
| **Los Angeles** | 36,786 | 34.0 | 71,426 | 66.0 |
| **San Bernardino** | 3,807 | 27.4 | 10,105 | 72.6 |
| **Riverside** | 3,473 | 20.9 | 13,167 | 79.1 |
| **Orange** | 13,346 | 23.6 | 43,186 | 76.4 |
| **Ventura** | 1,372 | 16.1 | 7,144 | 83.9 |

The highest rates of DAC/LIC participation were recorded for Imperial County (48.6%); followed by Los Angeles County (34.0%) and San Bernardino County (27.4%)

Per the findings of the spatial analysis, while most BEV owners were identified residing in non-urban areas (Fig.1a), this trend diminished as one travels east/northward into the more rural areas of the SCAG region. As indicated, DAC/LIC participation was highest within Imperial County, the most geographically isolated of SCAG counties, thus suggesting opportunities for expansion given the high proportion of marginalized communities.

**Table 2f: DAC/LIC Participation in CVRP**

| **DAC/LIC Status** | | | | |
|---|---|---|---|---|
| **County** | **% DAC/LIC Status** | **% Total CVRP Participation (by County)** | **Weighted Average (Participation)** | **% Total Population in the SCAG region** |
| **Imperial** | 48.6% | 0.10% | 0.049% | 0.96% |
| **Los Angeles** | 34.0% | 53.00% | 18.02% | 53.01% |
| **Orange** | 27.4% | 27.70% | 7.58% | 16.94% |
| **Riverside** | 20.9% | 8.20% | 1.71% | 12.96% |
| **San Bernardino** | 23.6% | 6.80% | 1.61% | 11.63% |
| **Ventura** | 16.1% | 4.20% | 0.68% | 4.49% |
| **SCAG Region (Sum)** | 34.8% | | 29.6% | 100.00% |

**Table 3f: Non-DAC/LIC Participation for BEV Owners by County**

| Neither Status (Weighted) | | | | |
|---|---|---|---|---|
| **County** | **% Non- DAC/LIC Status** | **% Total CVRP Participation (by County)** | **Weighted Average (Participation)** | **% Total Population in the SCAG region** |
| **Imperial** | 51.4% | 0.10% | 0.051% | 0.96% |
| **Los Angeles** | 66.0% | 53.00% | 35.0% | 53.01% |
| **Orange** | 72.6% | 27.70% | 20.1% | 16.94% |
| **Riverside** | 79.1% | 8.20% | 6.5% | 12.96% |
| **San Bernardino** | 76.4% | 6.80% | 5.2% | 11.63% |
| **Ventura** | 83.9% | 4.20% | 3.5% | 4.49% |
| **SCAG Region (Sum)** | 65.2% | | 70.4% | 100.00% |

*Summary:* As previously noted, most BEV participants came from Los Angeles County, followed by Orange County. These county participation proportions remained relatively the same when analyzing participation across vehicle types and BEV owners only.

Unsurprisingly, given its geographical remoteness relative to other counties in the SCAG region, Imperial County recorded the highest proportion of its participants being of DAC/LIC status, nearly half (48.6%). However, since Imperial County also has the lowest population in the SCAG region, this did not factor into influencing DAC/LIC representation in the CVRP across the SCAG region as a whole, where when weighted, this representation was found to equate to only 29.6% of all CVRP participants. Although this proportion is over double that recorded by Connelly et al., 2024 for the state as a whole (12.1%), given the fact in that the program was initially design ed to assist low- to moderate-income BEV owners, such figures fall slightly short of equitable representation given that DAC/LIC individuals comprise of 34.8% of the SCAG region's population. (Table 2f) As a preemptive policy recommendation, given that DAC/LIC participation was highest within Imperial County, i.e. the most geographically isolated of SCAG counties, opportunities for expansion within non-urban areas with low survey responsiveness, per the findings of ACS, 2022, should also be explored.

Imperial, Los Angeles, and Ventura counties participated at similar rates relative to their overall population. Orange County, a county with a higher median annual income per the findings of Fig.2b and Fig.2c, displayed significantly higher participation relative to its overall population by a factor of approximately +63.5%. Riverside and San Bernardino

Counties, counties with less urban land uses per the findings of Fig.1b and Fig.1c, displayed lower participation rates relative to their overall populations by factors of approximately -37.6% and -41.5%. This latter finding is surprising given that several outliers with higher rates of BEV ownership were observed in those areas. Given that these areas consisted of lower median annual income; higher renter populations; and higher minority populations per the findings of the spatial analysis for BEV ownership, these outliers should be examined more closely to analyze the efficacy of local strategies. A summary of local EV reimbursement programs and incentives for outliers observed in the spatial analysis for BEV ownership is provided in Table 4e based on ascending BV_CS values.

**Table 4e: Local EV Reimbursement Programs (EV Outliers)**

| Zip Code | City | BEV_CS | Local EV Reimbursement Programs/Policies/Actions | EV Outreach | Additional Notes |
|---|---|---|---|---|---|
| 92618 | Irvine | 27 | • One Irvine<br>• (charging stations) | • City Website<br>• City Events (e.g. Drive Electric Earth Day webinar) | • Extensive Public Charging Stations |
| 91789 | Walnut | 35 | • Municipal Code Title 2, Chapter 2.42 Expedited Electric Vehicle Charging Permits | • City Website | • Extensive Public Charging Stations |
| 90401 | Santa Monica | 36 | • Electrify Santa Monica (charging stations)<br>• Priority curb access for Zero-Emission Delivery Vehicles (LACI). | • EV Subcommittee (City Council)<br>• | • Extensive Public Charging Stations<br>• Free EV Parking |
| 91733 | South El Monte | 83 | • Clean Mobility Options Carshare Program (EVs, charging stations) | • Public-private partnerships (SGV)<br>• EV Charging Stations RFP | • Extensive Public Charging Stations |
| 92702 | Tustin | 138 | | • Corporate Outreach (Tustin Autocenter) | • Extensive Public Charging Stations |
| 92833 | Fullerton | 183 | • Climate Action Plan (CAP) Initiatives (EV Charging) | | • Extensive Public Charging Stations<br>• Streamlined permitting process for EV Charging Stations |

| Zip Code | City | | • **Local EV Reimbursement Programs/Policies/Actions** | • **EV Outreach** | • **Additional Notes** |
|---|---|---|---|---|---|
| 92602 | Irvine | 210 | • One Irvine<br>(charging stations) | • City Website<br>• City Events (e.g. Drive Electric Earth Day webinar) | • Extensive Public Charging Stations |
| 91770 | Fontana | 203 | • Alternative Fuel Rebate Program (EVs) | • Public-Private Partnerships | • |
| 90301 | Inglewood | 266 | • MC Code Chapter 11, Article 11-18: Electric Vehicle Charging Station Expedited Permitting | • Extensive public-private partnerships (EvGo)<br>• Educational Events (Communities for Change, National Drive Electric Week)<br>• Community Resources links (Communities Affairs website) | • Extensive Public Charging Stations<br>• Streamlined permitting process for EV Charging Stations |

*Summary*: Based on the analysis of EV reimbursement programs and incentives offered by outlier zip codes analyzed previously in the spatial analysis for BEV ownership, the streamlining the installation of EV charging stations is heavily prioritized, further supporting the assumption of land use-associated variables acting as a precursor for BEV ownership, per the findings of ACS, 2022 and NRC et al., 2015. Educational outreach and public-private partnerships are also common themes amongst outlier zip codes. Only one outliers, the City of Fontana (91770), provides its own City-specific EV reimbursement programs.

Fontana's Alternative Fuel Rebate Program provides a $500 rebate for EVs purchased in the City of Fontana. Although the program was originally reserved for all-natural gas or plug-in hybrid electric vehicles (PHEVs), the program's encouragement of purchases from a local dealership emphasizes the importance of public-private partnerships in the role of promoting BEVs seen elsewhere in the SCAG region.

Areas with low BEV_CS values, or areas with higher charging station availability (e.g. Santa Monica, Walnut) unsurprisingly contained EV charging station streamlining policies, to the extent that these were incorporated into the City Municipal Codes. These programs (e.g. Electricy Santa Monica, Walnut Municipal Code) include options not only for public facilities, but also for multifamily residential areas, providing options for homeowners and renters alike. Given these examples, extensive City-directed outreach, including innovative measures such as free curb access and parking (Santa Monica), could be considered in other areas of the SCAG region to incentivize BEV ownership, specifically high-trafficked areas in mixed-use settings.

Overall, an application of measures employed in "outlier" regions provided from the spatial analysis may provide a useful framework to encourage policy development elsewhere in the SCAG region. This may be especially useful when promoting BEV ownership within marginalized communities, as observed through the spatial analysis and as such may provide a path forward for encouraging BEV ownership in areas of low to moderate-median income status; areas of high proportion of Black population; areas of high Hispanic/Latino population; areas of high population density; and areas of high renter population.

## Conclusion

This study analyzed motivating factors influencing BEV ownership and charging station distribution. In doing so, it analyzed areas for improving BEV ownership (Table.2e) and areas for expanding public charging station access (Table.3e). It also explored participation in the state's premier EV reimbursement program, the CVRP, and how to improve participation rates based on the success of local programs.

The results of this study demonstrate the viability of prioritizing land use factors (e.g. homeownership tenure, population density) when analyzing potential for BEV ownership, and thus trip generation. By expanding BEV ownership in areas with high public charging station access (Table.3e) and by employing measures to encourage BEV ownership in such areas based on the efforts of local jurisdictions, SCAG has the potential to provide a path forward towards achieving AB 32 goals for greenhouse gas emissions reductions (CARB, 2020), in addition to providing other benefits including advancing equity and increasing housing stock. This study provides a framework for implementing these social justice and sustainability measures for the road ahead. A comprehensive List of Policy Recommendations is provided below for further elaboration.

It should be noted that the limitations of this study should also be considered. Due to time constraints, statistical testing on these observed variables was not performed. Deployment of a two-way t-test, or similar test, on these observed variables would provide a valuable opportunity for ranking these variables with respect to how they influence BEV ownership and public charging station distribution. Additionally, although this study focused on relatively populated areas of the SCAG region, the most remote areas of the SCAG region (e.g. Imperial County) were not explored in-depth for analysis of BEV ownership trends and charging station build-out efforts. To improve regional understanding of these relationships, a further in-depth analysis should be conducted within these regions, to further advance social justice and sustainability goals.

## List of Policy Recommendations

### *BEV Ownership*

1. Targeted BEV ownership outreach, education, and policy reform within zip codes listed in Table 3e and/or DAC-designated zip codes.
    a. Launch campaigns for public-private partnerships within these areas, mirroring the efforts of those described in Table.5f. Consider selective "bonuses" for BEVs purchased locally.
    b. Consider deployment of income-based rebate campaigns targeting areas with high renter populations.
    c. Conduct a transportation assessment study to determine possible areas for free BEV parking, particularly within highly trafficked areas adjacent to existing public charging stations, as noted in Table.5f.
        i. Deploy BEV rental programs for areas with high renter population, in conjunction
        ii. Consider assessment of designated curb areas for zero-emission fleets
    d. Forge community partnerships within Black- and Hispanic/Latino dominant zip codes. Apply for statewide grant opportunities to receive funding for these jurisdictions.
2. Target BEV ownership outreach, education, and policy reform within zip codes listed within the charging station spatial analysis for ACS-Considered variables.
    a. Include Russian and other Slavic languages, other Indo-European languages, and Tagalog within these areas.
    b. Given the proximity to UCLA and other educational institutions in the area, coordinate private partnerships with UCLA and other institutions to offer free parking for BEVs.
    c. Coordinate with UCLA and other educational institutions to promote a discount for EV rental programs (for students), a population less likely to use cars.

### *BEV Charging Station Distribution*

1. Strategize public charging station deployment within zip codes of high BEV ownership, with particular emphasis on zip codes within urban areas defined by CA Public Resource Code Section 21071 (Fig.1b)
    a. Stipulate streamlined residential EV charging station installations within TOD projects, in coordination with the Los Angeles Metropolitan Authority and the City of Los Angeles.

    i. Provide a blueprint for cities to launch similar programs, based on the examples provided in Table.5f.

b. Encourage Citywide collaboration towards improving public charging station access. Encourage public input through the coordination of bimonthly subcommittee meetings for BEV owners and interested parties.
c. Increase public charging station within areas of emerging BEV ownership, particularly within the Inland Empire, in addition to highly trafficked truck routes such as Hwy.10. and Hwy.57.

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