

Charged and Disconnected: Unequal Access to Electric Vehicle (EV) Infrastructure in Maricopa County

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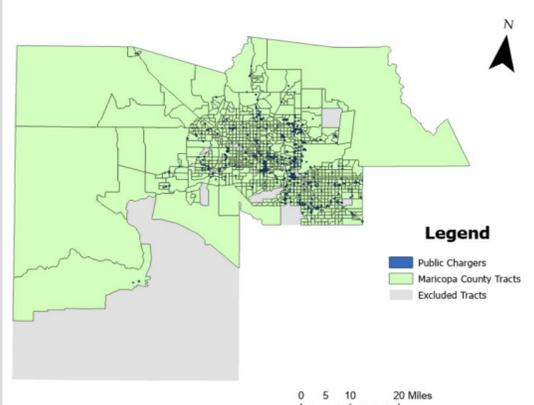
Introduction

- Adoption of EV technology is currently a key pathway towards decarbonization of Arizona's transportation sector and wider economy¹
- Lower income and minority communities remain underserved and due to lacking charging infrastructure remain unmotivated to adopt EVs^{2,3}
- Better understanding of which populations demographics in AZ are currently lacking in access is necessary to develop a more holistic and just EV charging landscape
- Since EV charging can be 20 mins. +, access is limited to populations living within a walkable distance from a public charging station
- Existing work tend to favor binary, spatial coincidence models to examine accessibility^{4,5}
- However, a population density-based charging metric can better represent accessibility in the context of EV charging

Study Area

- Maricopa County includes 26 distinct towns and cities with varying electrification agendas
- Maricopa County has one of the top 5 fastest growing populations and Arizona is one of top 10 fastest growing EV markets in the country^{6,7}
- Cities such as Phoenix predict an 850% increase in EVs by 2030 and have equity and distributional equality at the center of their electrification roadmap⁷

Figure 1: Maricopa County Public Charger Distribution

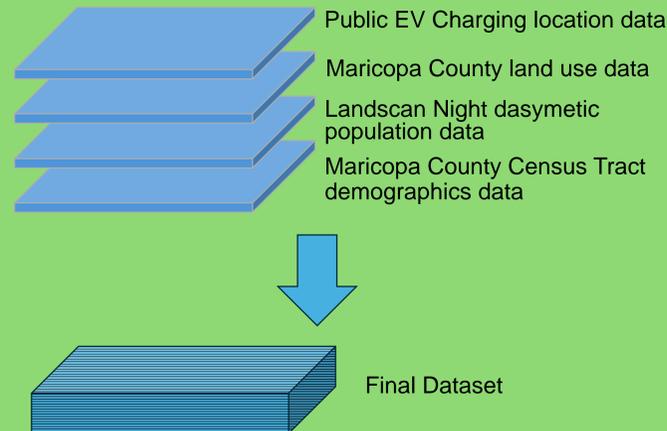


Research Questions

- How are public EVCS distributed across Maricopa County's population and its diverse socio-economic demographics and land use patterns?
- How does access to EVCS differ when measured by incorporating walkability-based population density metrics compared to the spatial coincidence metrics?

Methods

STEP 1: Dataset creation

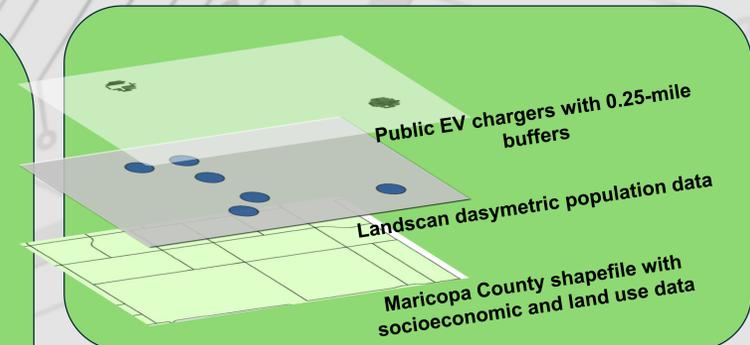


STEP 2: Developing a population Density based metric

- We created 0.25 -mile buffers around public EV charger locations derived from DOE's Alternative Fuel Data Center
- These buffers were spatially overlaid in ArcGIS with Landscan dasymmetric population distribution raster and Maricopa County's census tract level socio-economic demographics shapefile
- This allowed us to calculate the Public Charger Density (PCD) for each census tract using the formula:

$$PCD(per\ tract) = \frac{Population\ within\ buffer(s)}{Total\ population}$$

- Additionally, a binary metric was also calculated where 1 was assigned to each tract with at least 1 public charger and 0 for all others



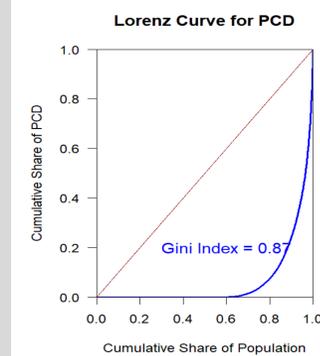
STEP 3: Data Analysis

- Using R, we calculate Gini scores using PCD and a weighed version of the binary access variable
- Next, we conduct a linear regression analysis using PCD as a dependent variable and covariates listed in table below
- Lastly, we run a logit regression using the binary access variable and compare results from both models

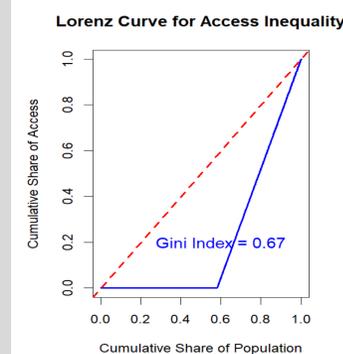
Results

Figure 2 Lorenz Curve and Gini Index

a. PCD model



b. Binary model



Research Question 1:

- Black and Asian populations in Maricopa County remain significantly disincentivized to adopt EVs due to fewer public charging options
- In Maricopa County charging access increases as household income decreases and renter population increases
- Public Charging options also increase as proportion of highly educated households increase
- Proximity to highway exits remains the largest indicator of where public charging stations are being sited in the existing landscape

Figure 3: Public Charging access 0.25-mile Buffers – Census tracts

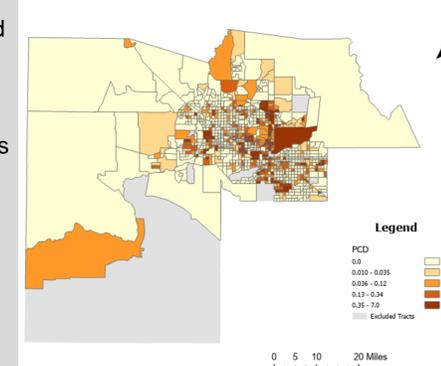


Figure 4: Public Charging Binary Access – Census tracts

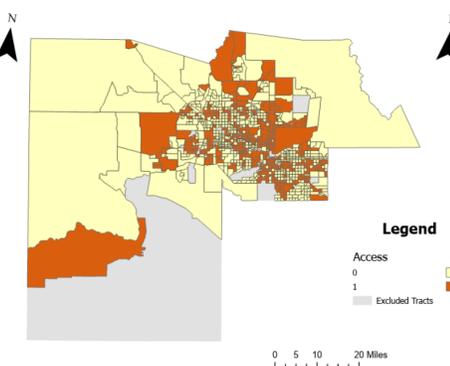


Table 1: Probability of having access to EV charging per standard deviation as per PCD (left) and spatial coincidence (right) models

Variable	Multiple Regression Model - PCD		Logit Regression Model - Binary	
	Sig.	Effect	Effect	Sig.
<i>Race and Ethnicity</i>				
Black Proportion	*	-2.20%	-2.11%	
Asian Proportion	*	-2.42%	-1.67%	
Other Minority Proportion		-3.40%	-0.05%	
Proportion of Hispanics		-2.96%	2.00%	
<i>Socio-economic status variables</i>				
Median Income	*	-5.41%	-2.95%	
Median Age		-2.62%	1.13%	
Renter Population	**	7.39%	4.59%	
Graduate Proportion	***	11.98%	12.03%	***
Population Density		3.10%	0.51%	
<i>Land use variables</i>				
Highway Exit Chargers	***	24.45%	74.12%	***
Residential Proportion		0.57%	-1.97%	

Research Question 2:

- Compared to spatial coincidence based binary access logit regression model, the PCD model is better suited to highlight racial and some socio-economic distributional injustice
- The logit regression model only finds significance for highway exit proximity and proportion of populations with a graduate degree
- Gini index values for PCD based metric redefines access as limited to households within 0.25-mile of a public EVCS and highlights distributional inequality as access is limited to a very small share of the population

Significance

In Maricopa County, extreme summer weather conditions necessitate redefining EV access to be limited to walkable distances. Using the population density-based metric we find:

- Local and state policy action is necessary to electrify currently underserved communities
- This work presents a census tract level understanding of which communities remain underserved and should be targeted by the equity minded electrification goals put forth by some of Maricopa County municipalities

References

