Understanding the Opportunity-centric Accessibility for Public Charging Infrastructure

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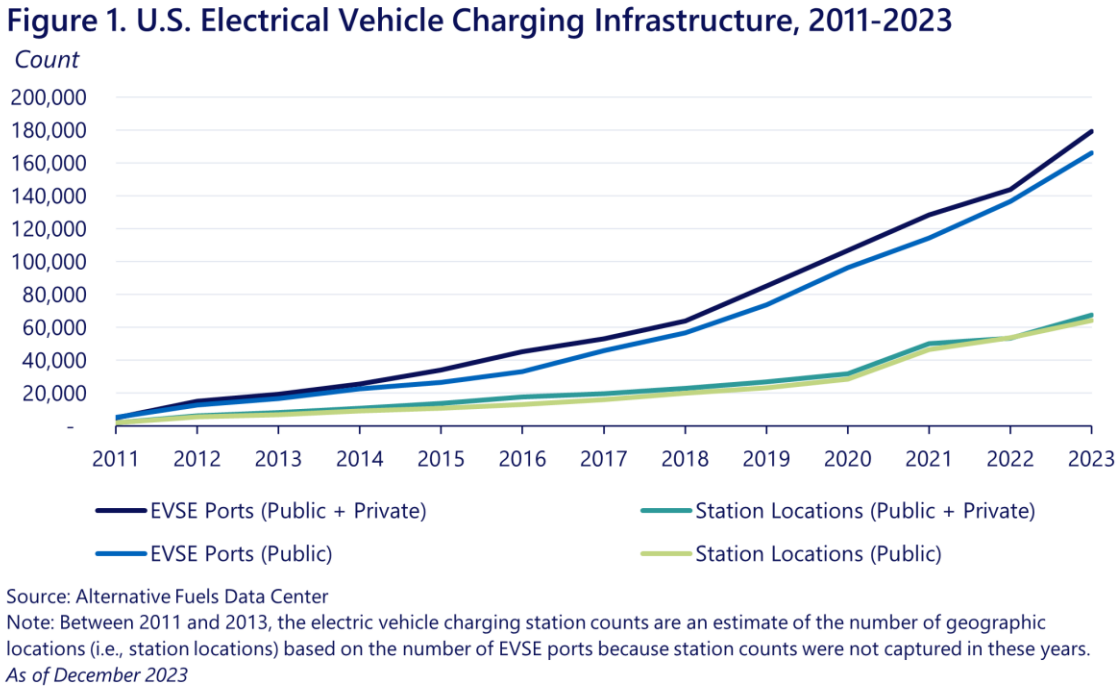
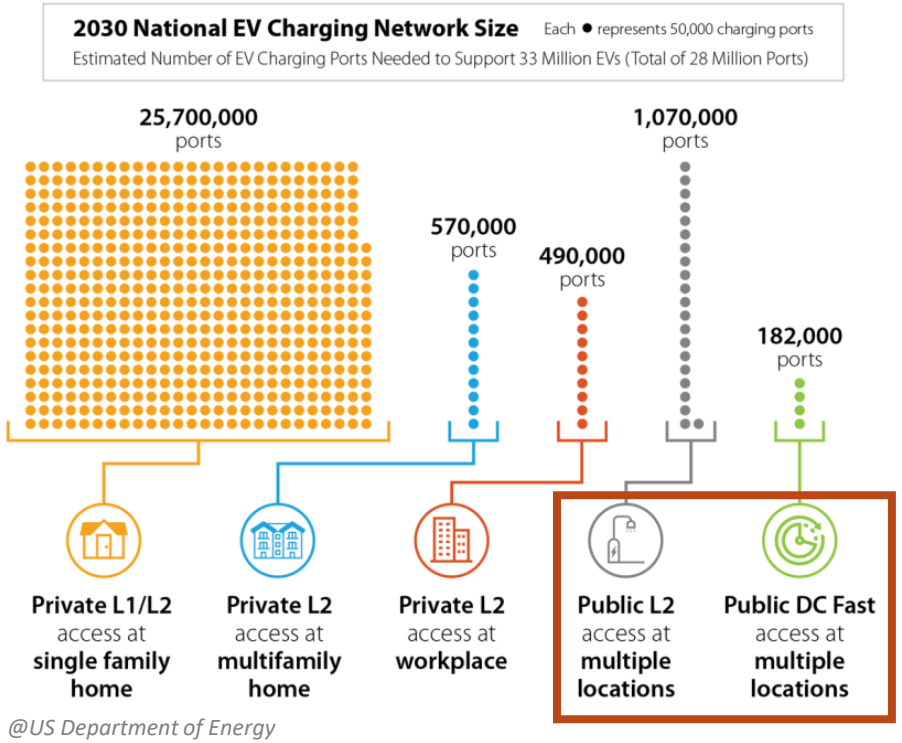
Joint TEXITE/ITS-TX Meeting
Houston | Nov 2024

Public EV Charging Infrastructure

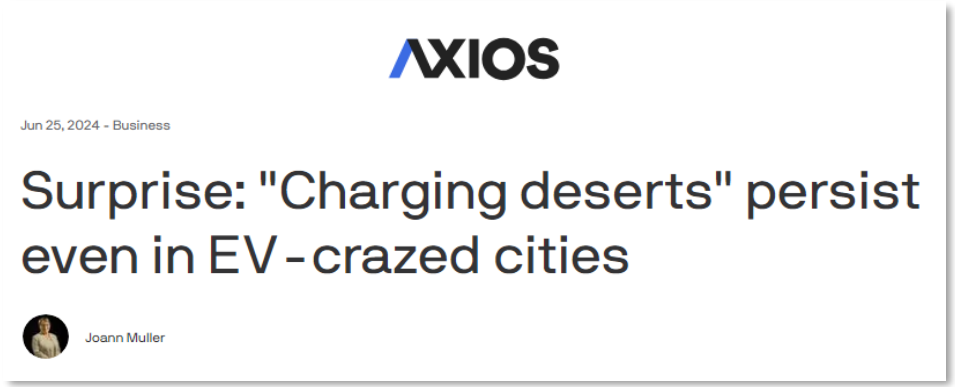
- 68,000 Public Charging Stations nationwide as of Nov 2024 (AFDC)
- 500,000 Public Charging Stations Targeted by 2030 (planned under BIL)

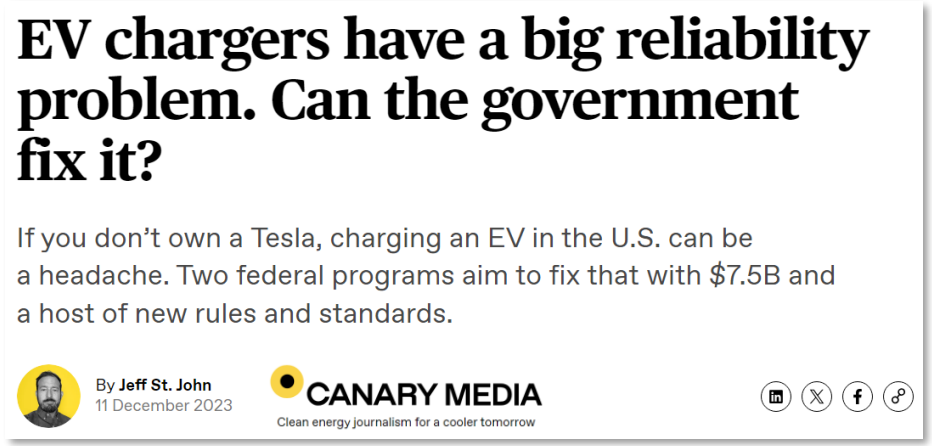




How Are We Deploying Charging Stations?

- While reliability and pricing continue to pose challenges, one **critical barrier lies in accessibility to public charging infrastructure**

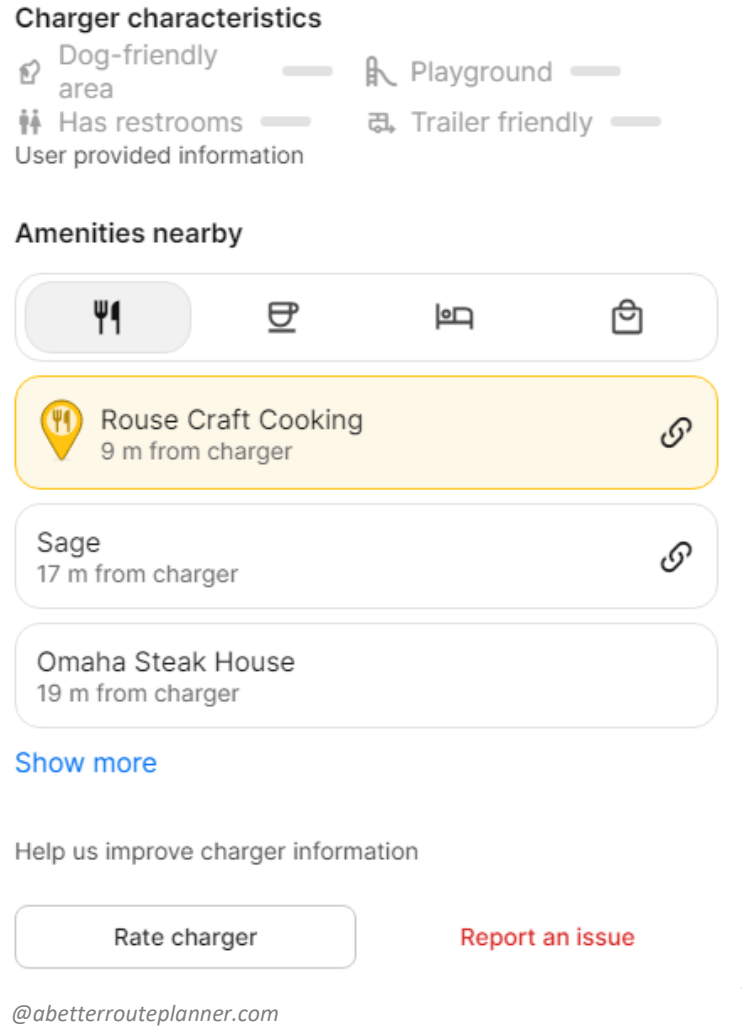




How EV Users Charge?

- **Public charging typically takes at least 20-30 minutes**, giving EV users time to engage in nearby amenities, like dining or shopping
- **Charging becomes a secondary activity**, often influencing the choice of location based on available amenities

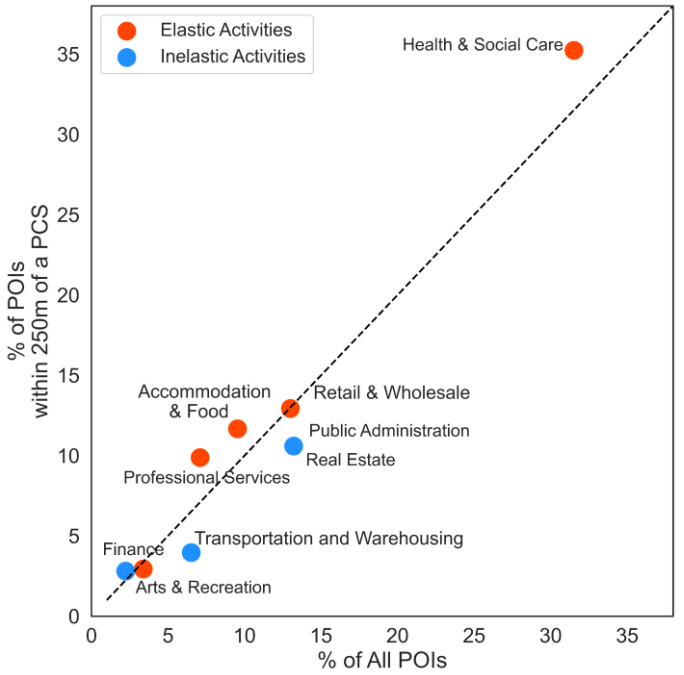
How does this shift our understanding of accessibility?



US Department of Transportation. Charger Types and Speeds. https://www.transportation.gov/rural/ev/toolkit/ev-basics/charging-speeds

Activities and Charging Opportunities

- Public charging stations (PCSs) are **more common near certain activities and certain brands**
- More locations attached to a station (compared to metro level):
  - 7.2% more for “Snack and Nonalcoholic Beverage Bars”
  - 58.2% more for “Casinos”
  - 19.8% less for “Public Administration and Other Services”
  - 39.2% less for ”Transportation and Warehousing”
- For grocery places in Florida (by 2023):



*Across 20 metro areas covering 49% of urban PCSs

Highest PCS coverage

WHOLE FOODS MARKET (%50.0)

The Spice & Tea Exchange (%28.6)

Wild Fork (%28.6)

Lowest PCS coverage

ALDI (%4.4)

Publix (%5.5)

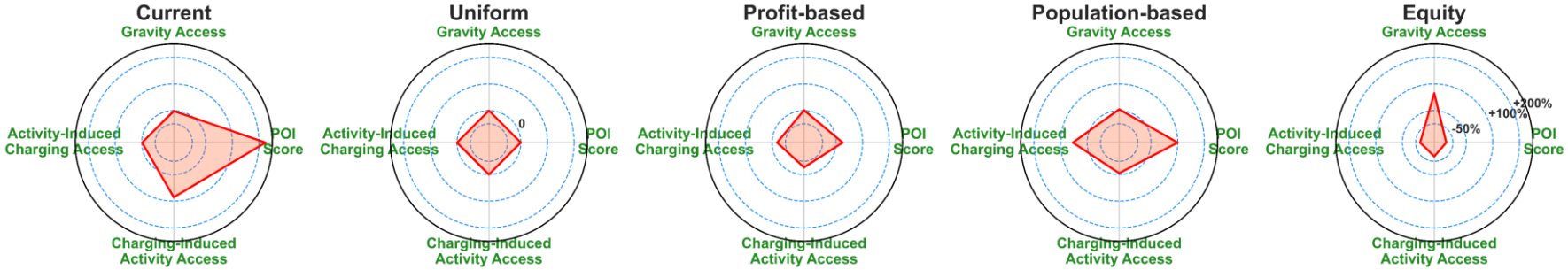
Winn-Dixie (%7.8)

Opportunity-Centric Charging Accessibility

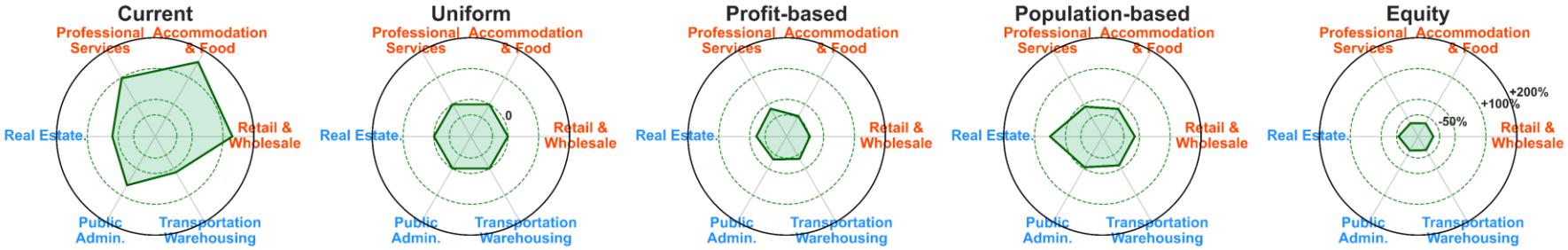
- Accounting for the daily opportunities nearby charging stations (charging-first and activity-first)
- Current deployment plan vs other scenario across activity categories

Equitable deployment is not necessarily *equitable*!

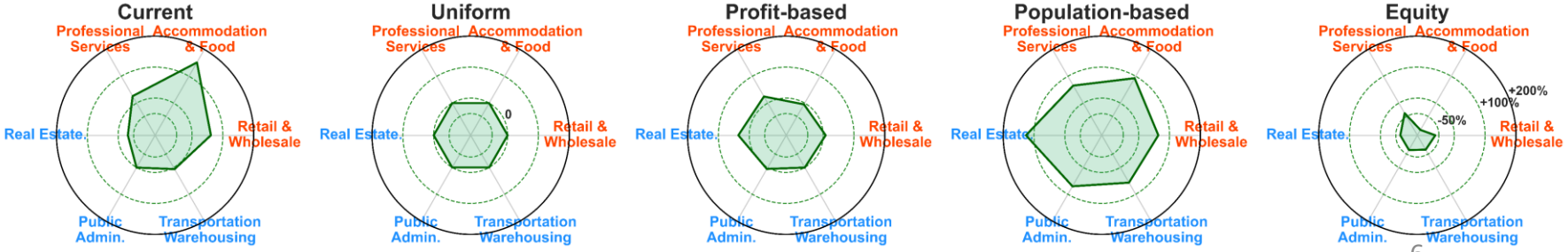
scenario performance



charging-induced activity



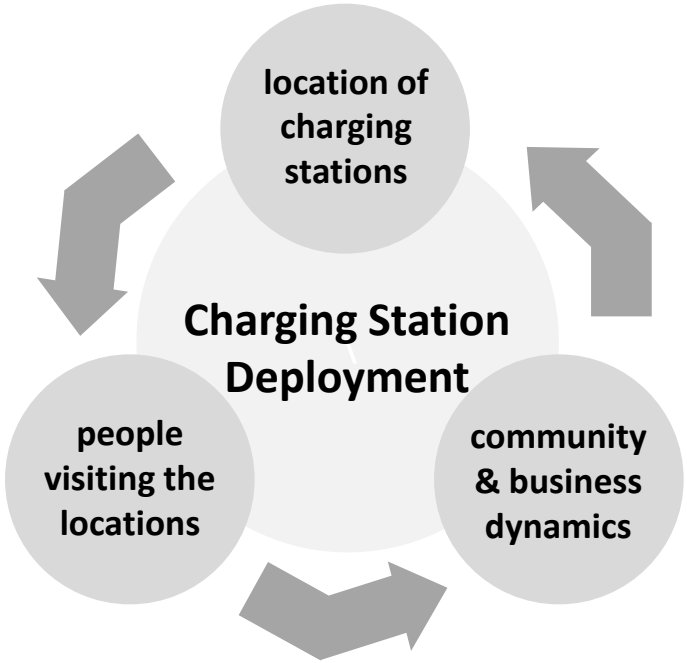
activity-induced activity



Gazmeh, H, Guo, Y, and Qian, X. (2024) Understanding the opportunity-centric accessibility for public charging infrastructure. Transportation Research Part D*

Movement Patterns and Charging Infrastructure

- Accounting for the presence of activity opportunities still might not be enough
- We need to understand the community's movement patterns
- Using data on anonymized foot traffic data from >35MM GPS devices visiting >18MM unique Points of Interest (POIs)



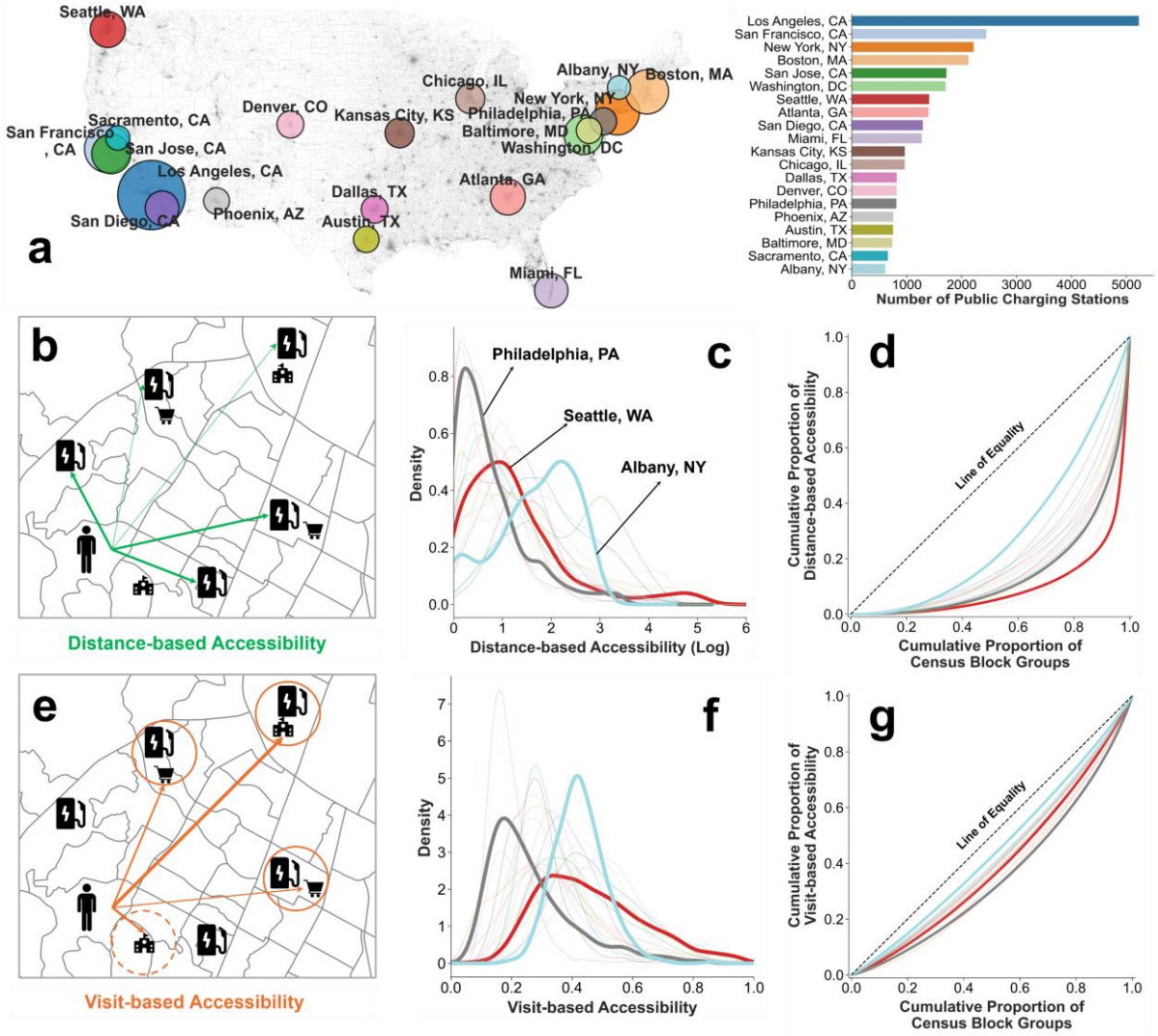
Who is more exposed to the charging infrastructure? Potential barriers in access?

SAFEGRAPH
Points of Interest (POIs)

DEWEY
Foot Traffic & Spending Patterns

Visit-based Charging Accessibility

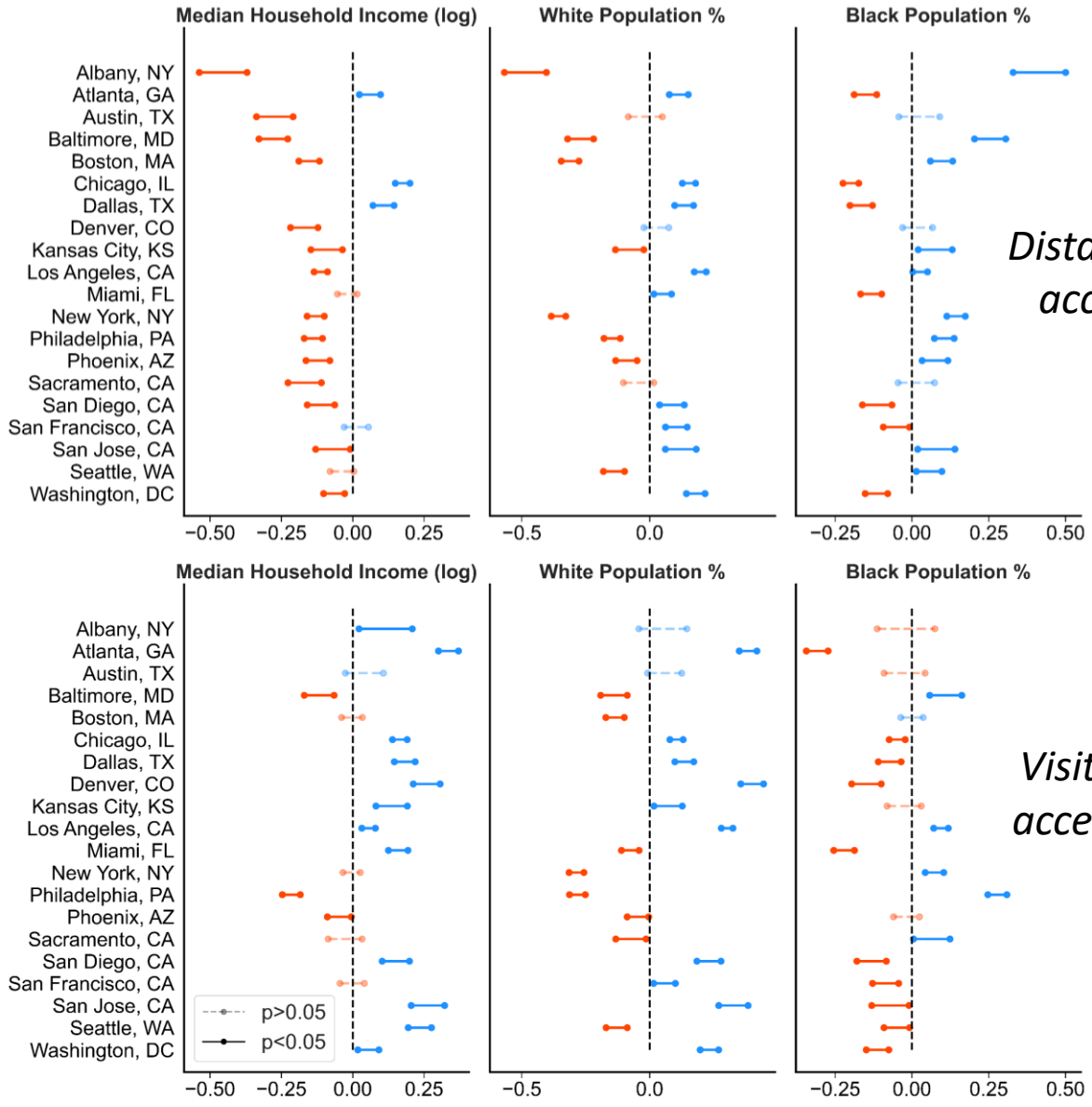
- Analyzing the movement patterns for the top 20 metro areas (~49% of all urban charging stations).
- Distance-based accessibility: a gravity model of reaching the nearest stations (b).
- Visit-based accessibility: expected chance of accessing a charging station within a walking distance of daily activities (e).
- Different equality of distributions (d & g)



Gazmeh, H, et al. (2024) Urban Mobility Reveals Social Barriers of Charging Infrastructure Accessibility. Working paper.

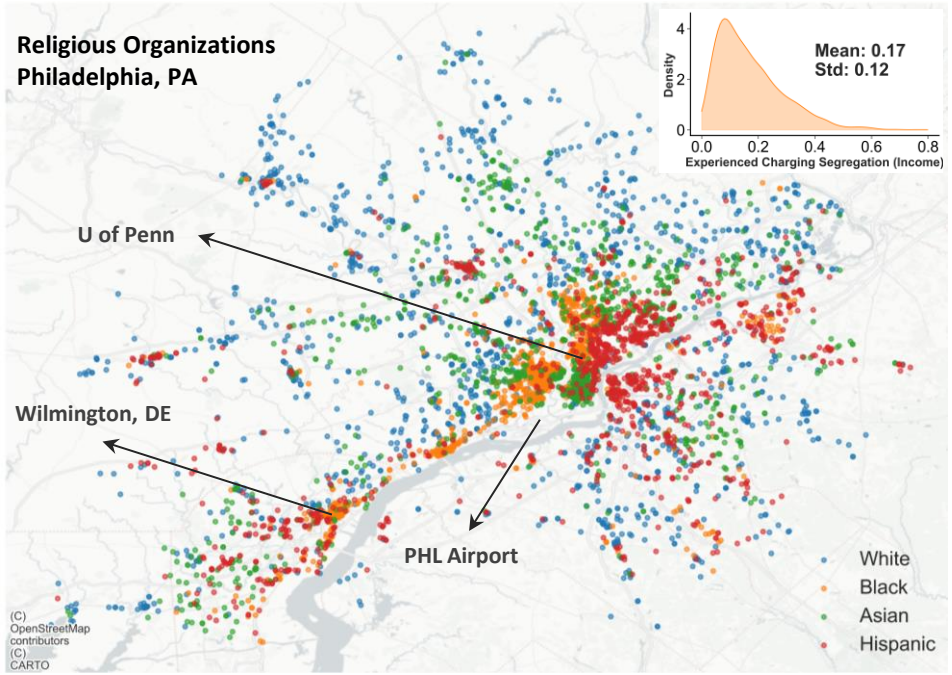
Visit-based vs. Distance-based Charging Accessibility

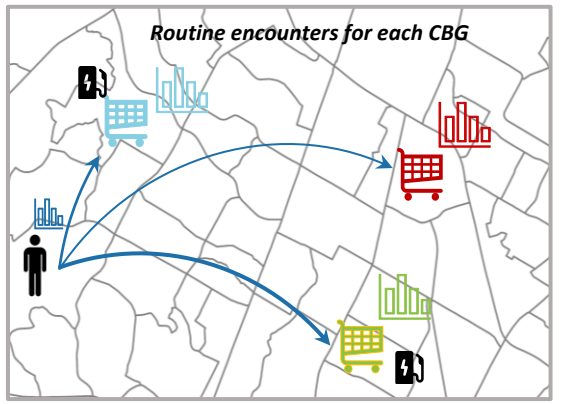
- Major bias in terms of the income levels compared to distance-based accessibility
  - (-) Distance-based (14/20)
  - (+) Visit-based (12/20)
- **Vulnerable communities live closer to charging infrastructure but engage with it less**, while higher-income groups interact with it more frequently during daily activities

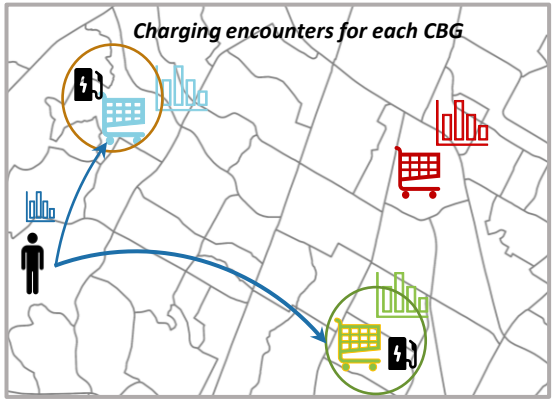


Social Barriers of Charging Accessibility

- Disparities in visit-based charging accessibility are rooted in distinct mobility patterns, extending to infrequently visited categories.
- How can we account for this to analyze which factors lead some communities to experience greater exposure to charging infrastructure?
- We examine income and racial encounters in visits to charging stations (compared to routine activity encounters)

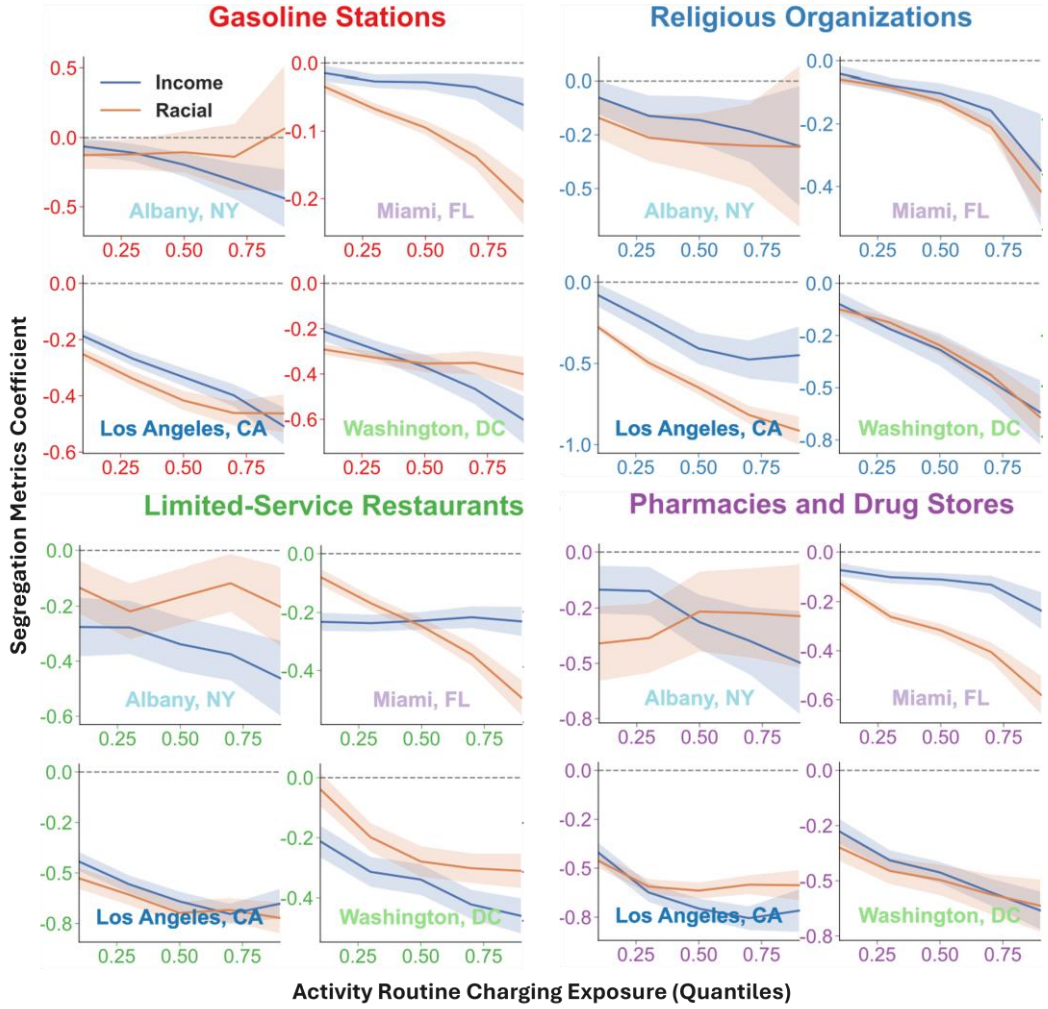






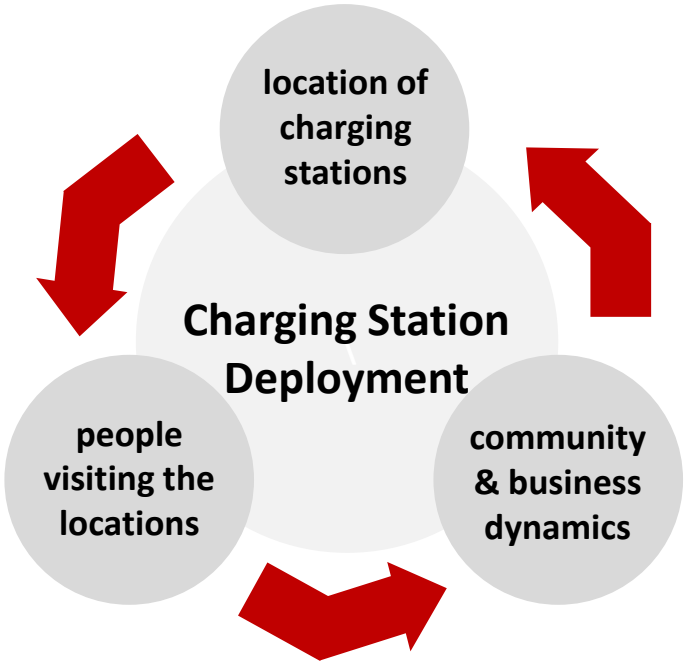
Social Barriers of Charging Accessibility

- There is a significant ($p < 0.05$) negative association between income and racial segregation and charging exposure across most metro areas, suggesting that **greater social segregation at POIs near charging stations (within 250 meters) is linked to lower visit rates to those POIs**.
- Differences between categories may stem from the essential nature of services used broadly across income groups (e.g., dining) or those more closely linked to racial demographics (e.g., religious activities).



Summary

- Charging is not only a travel decision but also a social activity
- Not everyone has equal access to charging stations where lower-income communities face lower chances of accessing it
- There are social barriers in access to public charging infrastructure that are closely tied to place-level income and racial segregations



Thank You!

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