Exploring Equity in EV Infrastructure

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INTRODUCTION

- EV adoption is rising rapidly in urban areas, increasing the need for reliable public charging infrastructure.
- We Investigate whether charger placement in the Twin Cities aligns with actual EV ownership and vehicle type.
- Our analysis focuses on whether chargers are equitably distributed relative to need.

OBJECTIVES

- Examine the relationship between EV ownership and charger density by ZIP code.
- Determine if expensive EVs are more likely to be supported by public chargers.
- Identify ZIP codes with misalignment between EV presence and infrastructure.

DATA & METHODS

- Data was taken from the Minnesota Public Utilities Commission's electric vehicle registration data as well as the US Department of Energy's Alternative Fuels Data Center.
- Each EV in MSP was assigned an MSRP based on make and model
- Each charger and EV was grouped by ZIP code, with average MSRP, total MSRP, and total vehicle count calculated for each area.
- The Pearson correlation method was used to measure a linear relationships between charger density, EV count, average MSRP, and income.
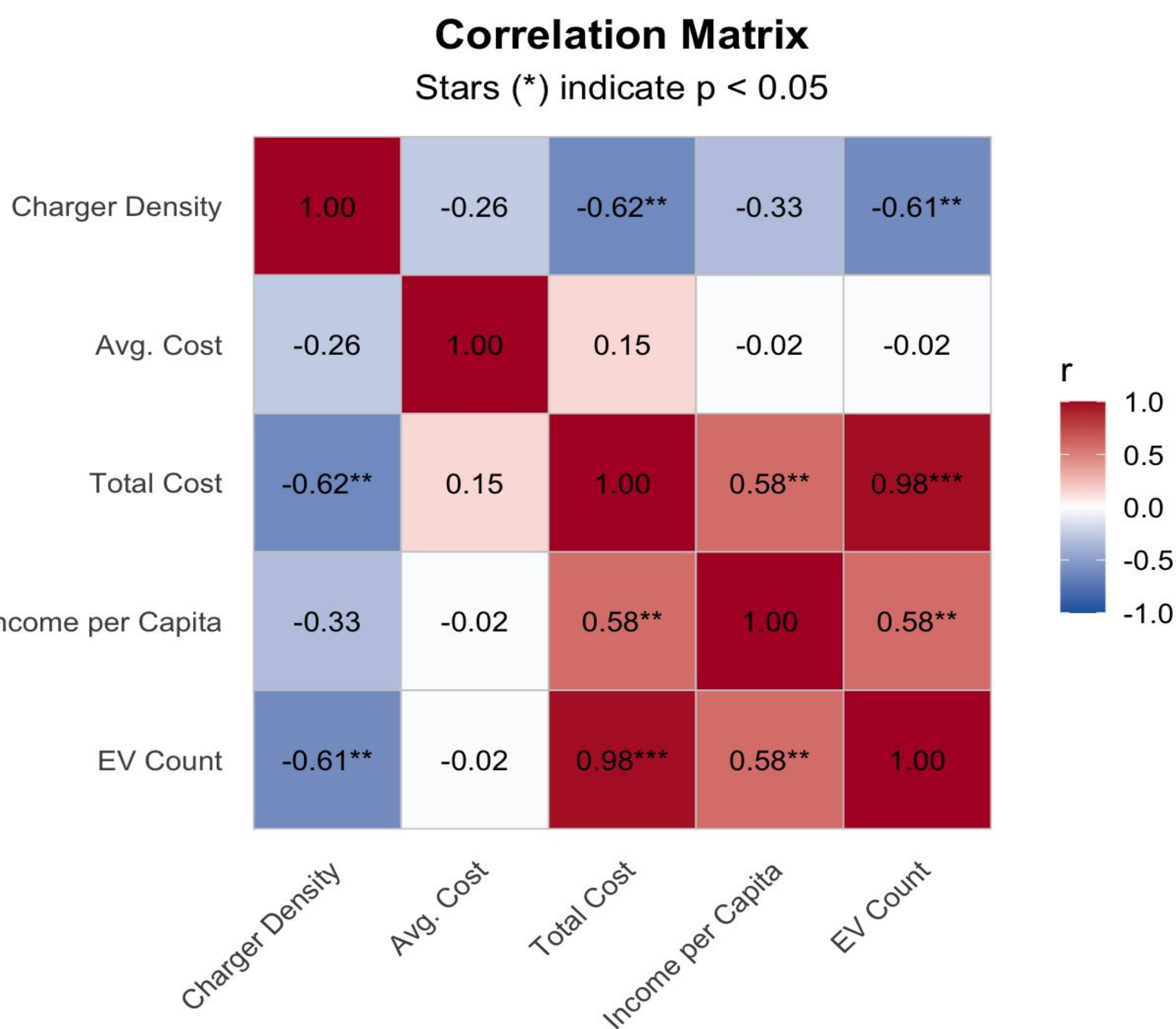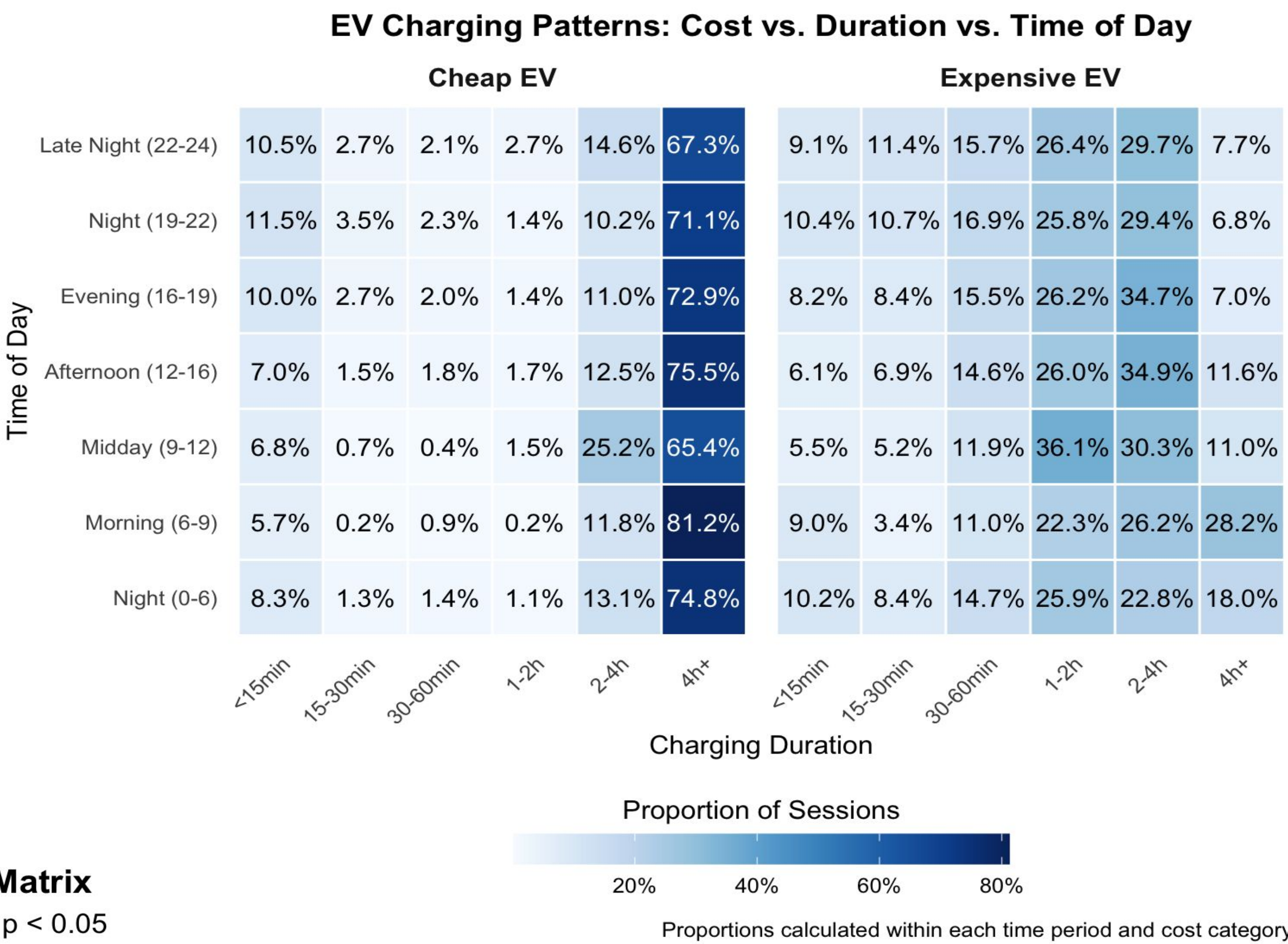
KEY FINDINGS

EV Charger Density & EV Count by ZIP
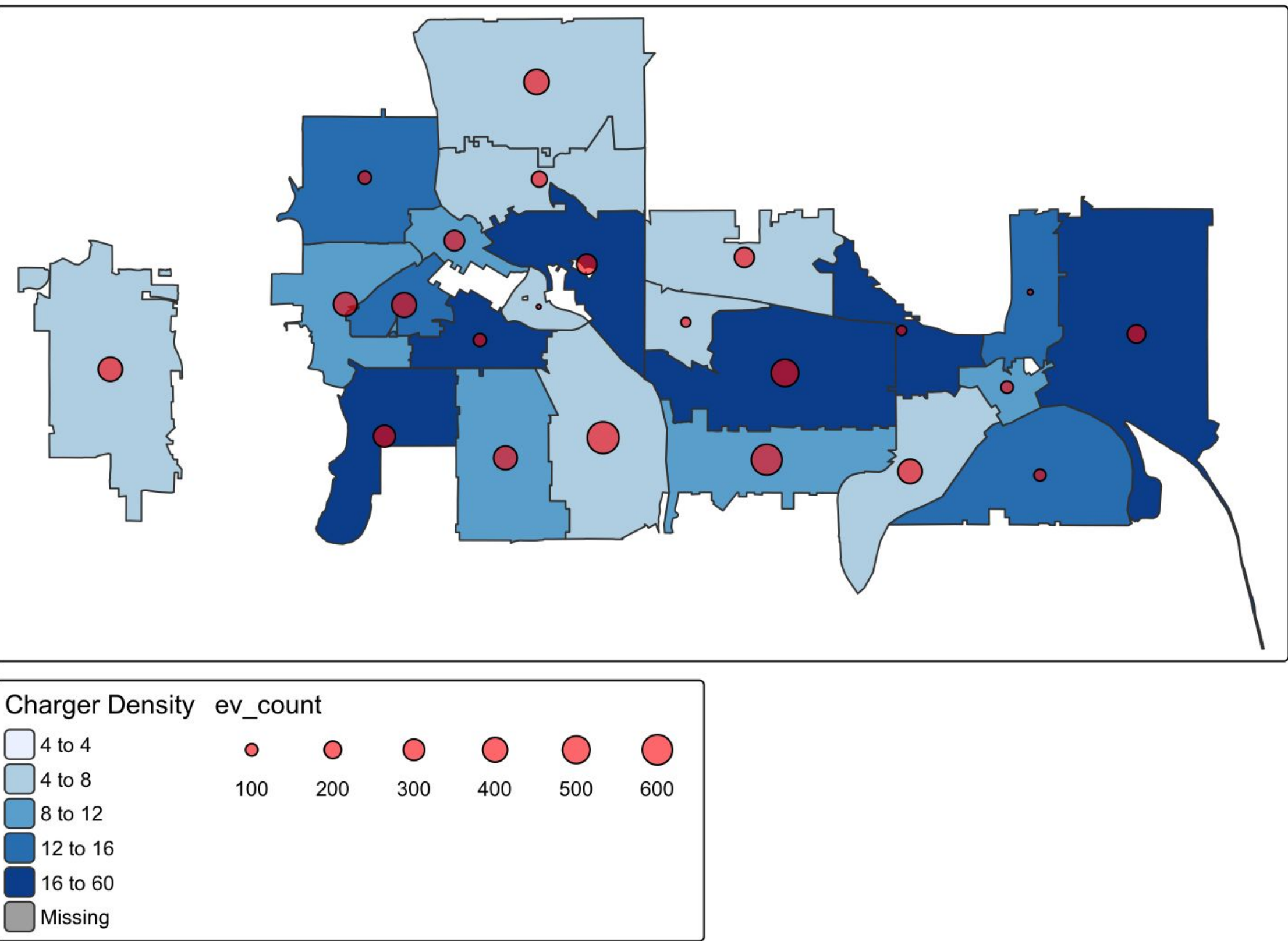
- Some ZIP codes with high EV counts have relatively low charger density, signaling a mismatch.
- High charger density is more prevalent in central and eastern ZIPs, not always where EV ownership is highest.

- Charging patterns suggest access gaps: Expensive EVs charge longer and more conveniently; cheaper EVs rely on short, off-peak sessions due to limited access.

EV Charging Patterns: Cost vs. Duration vs. Time of Day

	Cheap EV						Expensive EV					
Time of Day	<15min	15-30min	30-60min	1-2h	2-4h	4h+	<15min	15-30min	30-60min	1-2h	2-4h	4h+
Late Night (22-24)	10.5%	2.7%	2.1%	2.7%	14.6%	67.3%	9.1%	11.4%	15.7%	26.4%	29.7%	7.7%
Night (19-22)	11.5%	3.5%	2.3%	1.4%	10.2%	71.1%	10.4%	10.7%	16.9%	25.8%	29.4%	6.8%
Evening (16-19)	10.0%	2.7%	2.0%	1.4%	11.0%	72.9%	8.2%	8.4%	15.5%	26.2%	34.7%	7.0%
Afternoon (12-16)	7.0%	1.5%	1.8%	1.7%	12.5%	75.5%	6.1%	6.9%	14.6%	26.0%	34.9%	11.6%
Midday (9-12)	6.8%	0.7%	0.4%	1.5%	25.2%	65.4%	5.5%	5.2%	11.9%	36.1%	30.3%	11.0%
Morning (6-9)	5.7%	0.2%	0.9%	0.2%	11.8%	81.2%	9.0%	3.4%	11.0%	22.3%	26.2%	28.2%
Night (0-6)	8.3%	1.3%	1.4%	1.1%	13.1%	74.8%	10.2%	8.4%	14.7%	25.9%	22.8%	18.0%

Charging Duration

Proportion of Sessions
20% 40% 60% 80%
Proportions calculated within each time period and cost category

Correlation Matrix
Stars (*) indicate p < 0.05

	Charger Density	Avg. Cost	Total Cost	Income per Capita	EV Count
Charger Density	1.00	-0.26	-0.62**	-0.33	-0.61**
Avg. Cost	-0.26	1.00	0.15	-0.02	-0.02
Total Cost	-0.62**	0.15	1.00	0.58**	0.98***
Income per Capita	-0.33	-0.02	0.58**	1.00	0.58**
EV Count	-0.61**	-0.02	0.98***	0.58**	1.00

r: 1.0 / 0.5 / 0.0 / -0.5 / -1.0

- Charger density doesn't align with EV cost or ownership, indicating that infrastructure isn't keeping pace with demand. This suggests charger placement may be driven more by policy, zoning, or visibility goals than by actual EV usage patterns.

CONCLUSIONS

- Charging behavior differs significantly by EV cost, highlighting disparities in access and flexibility. Owners of expensive EVs tend to charge during the day and for longer durations, while cheaper EV owners rely on shorter, off-peak sessions, suggesting unequal access to convenient charging options.
- Infrastructure appears mismatched, leaving some high-EV areas underserved. ZIP codes with dense EV ownership often lack proportional charger coverage, suggesting a gap between demand and infrastructure.
- Future charger placement should reflect actual usage and access needs. Planning should be based on EV ownership, income, and transit access to ensure chargers are located where they will be most effective and equitable.

RESOURCES

- Minnesota Public Utilities Commission's electric vehicle registration data
- US Department of Energy's Alternative Fuels Data
- Census Income data by ZIP code
- Taamneh, M. M., & Makahleh, H. Y. (2025a). The prospects of adopting electric vehicles in urban contexts: A systematic review of literature. Transportation Research Interdisciplinary Perspectives, 31, 101420.

ACKNOWLEDGEMENTS

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