2025 Modeling Mobility Conference
Sep 16, 2025, 3:30 – 5:00 PM

How Can We Spend Electric Vehicle Incentives Smarter?

A Machine Learning Approach to Enhancing Rebate Efficiency in Varied Local Contexts

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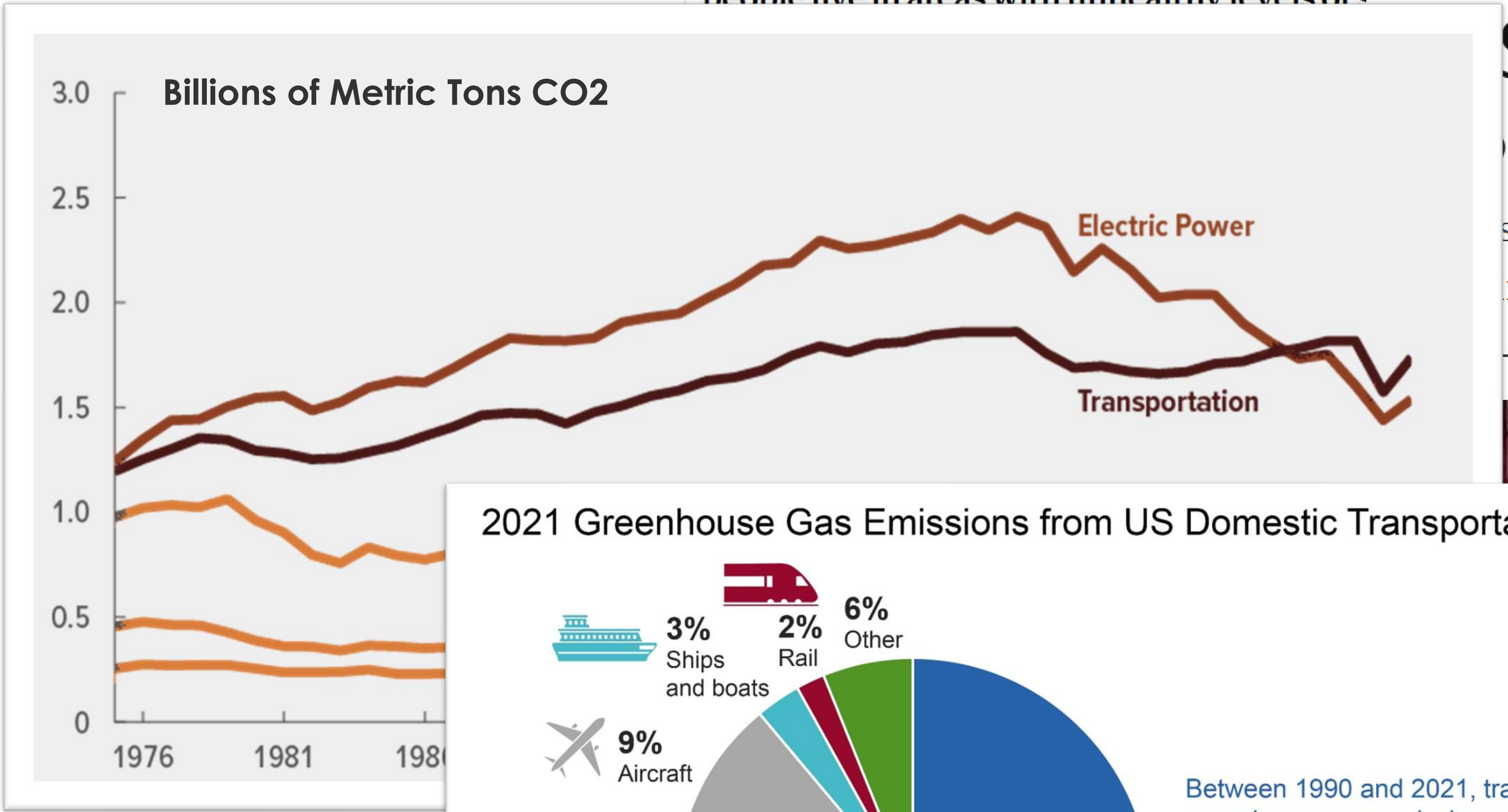
momo2025

What is EV Rebate? Why Sustainable Transportation?

The Guardian

Nearly half of Americans breathing in unsafe levels of air pollutants – report

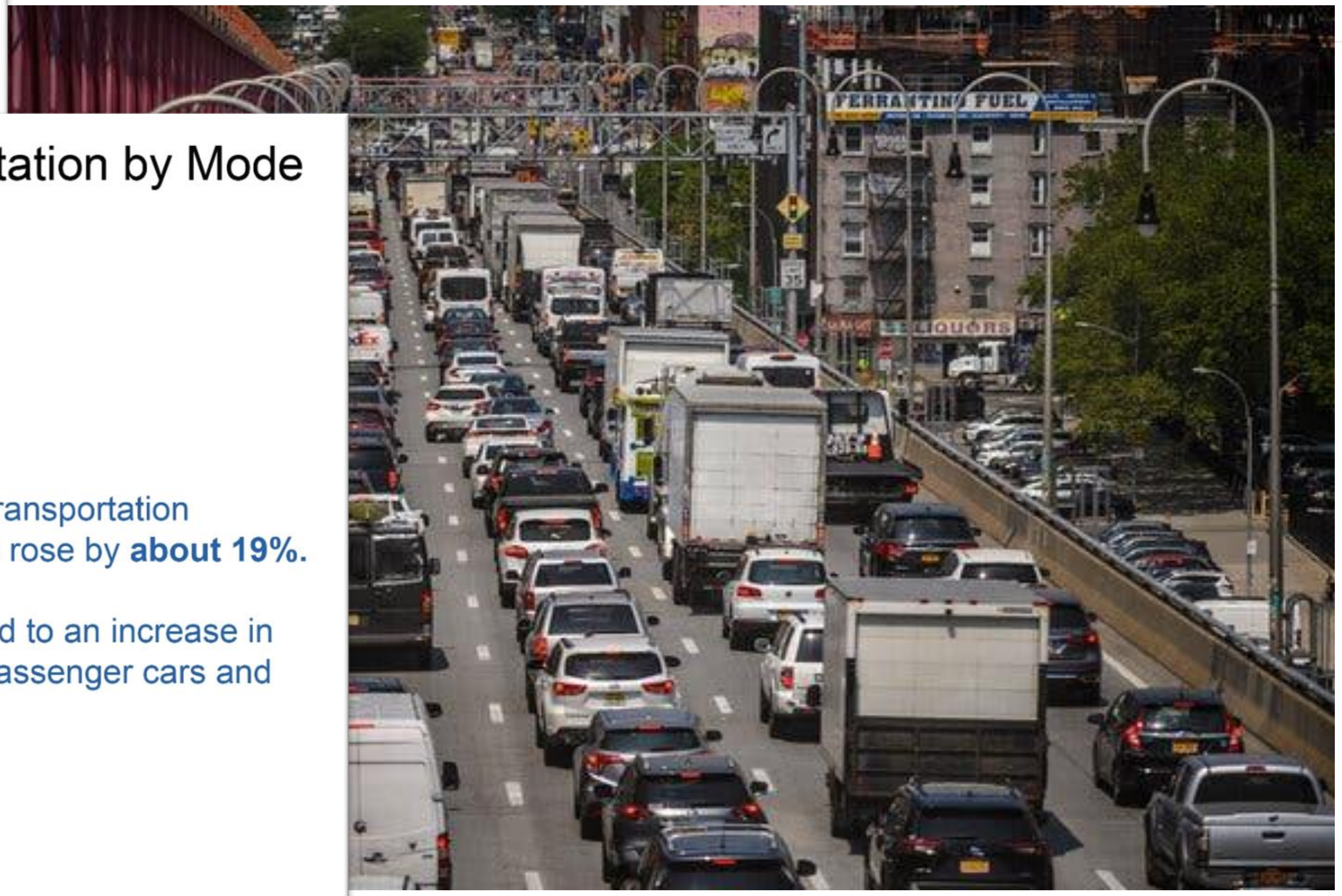
American Lung Association's study says alm
people live in areas with unhealthy levels of s

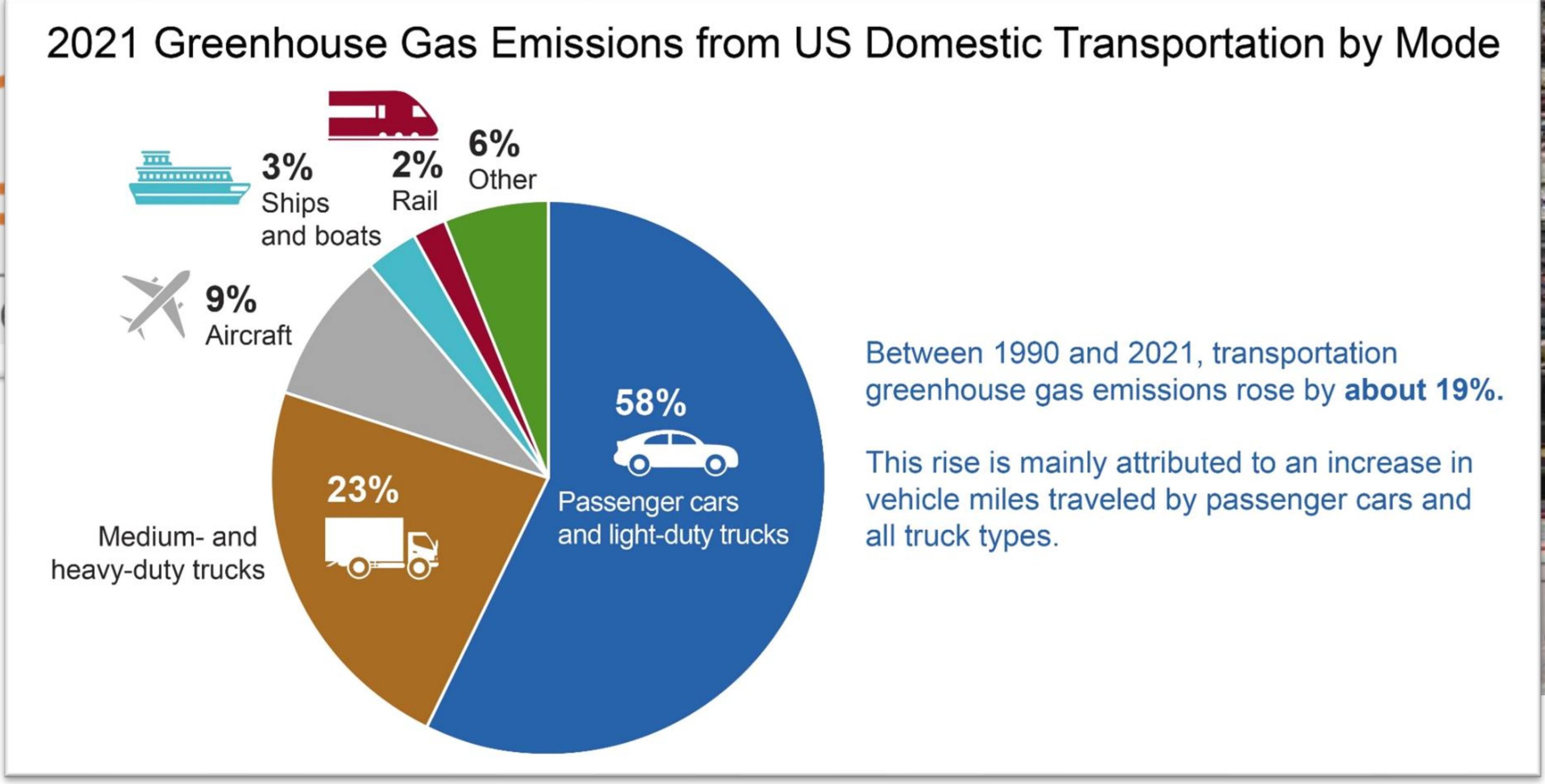


The New York Times

S. Greenhouse Gas Emissions unced Back Sharply in 2021

ssions rose 6 percent last year after a record 10 percent
ne in 2020, fueled by a rise in coal power and truck traffic as
J.S. economy rebounded from the pandemic.





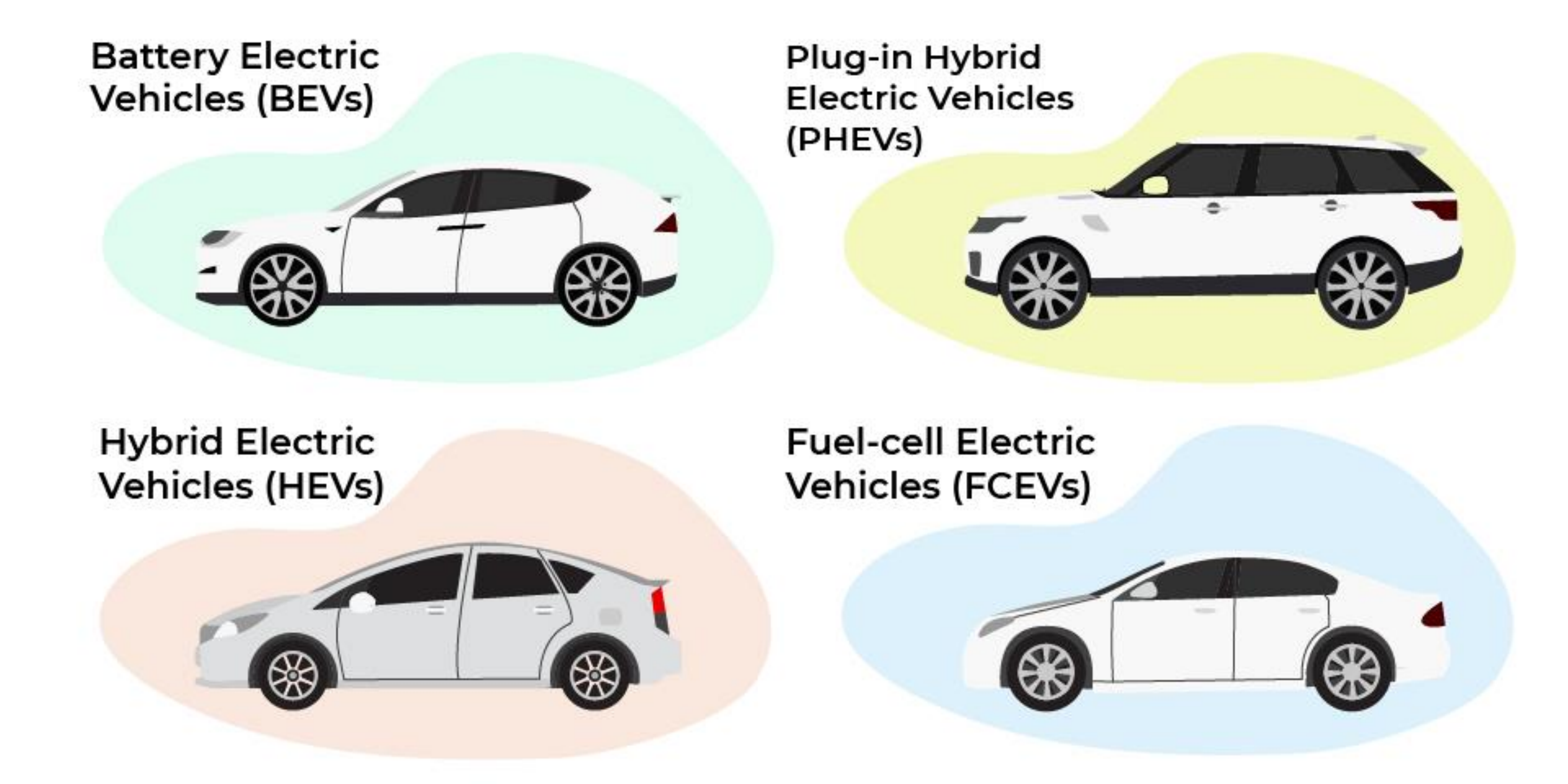
Behavioral Interventions to Promote Clean Transportation

Mode shift	Increasing vehicles' occupancy	Clean vehicle Alternatives
Travel reduction	Route/time optimization	…

Behavioral Interventions to Promote Clean Transportation

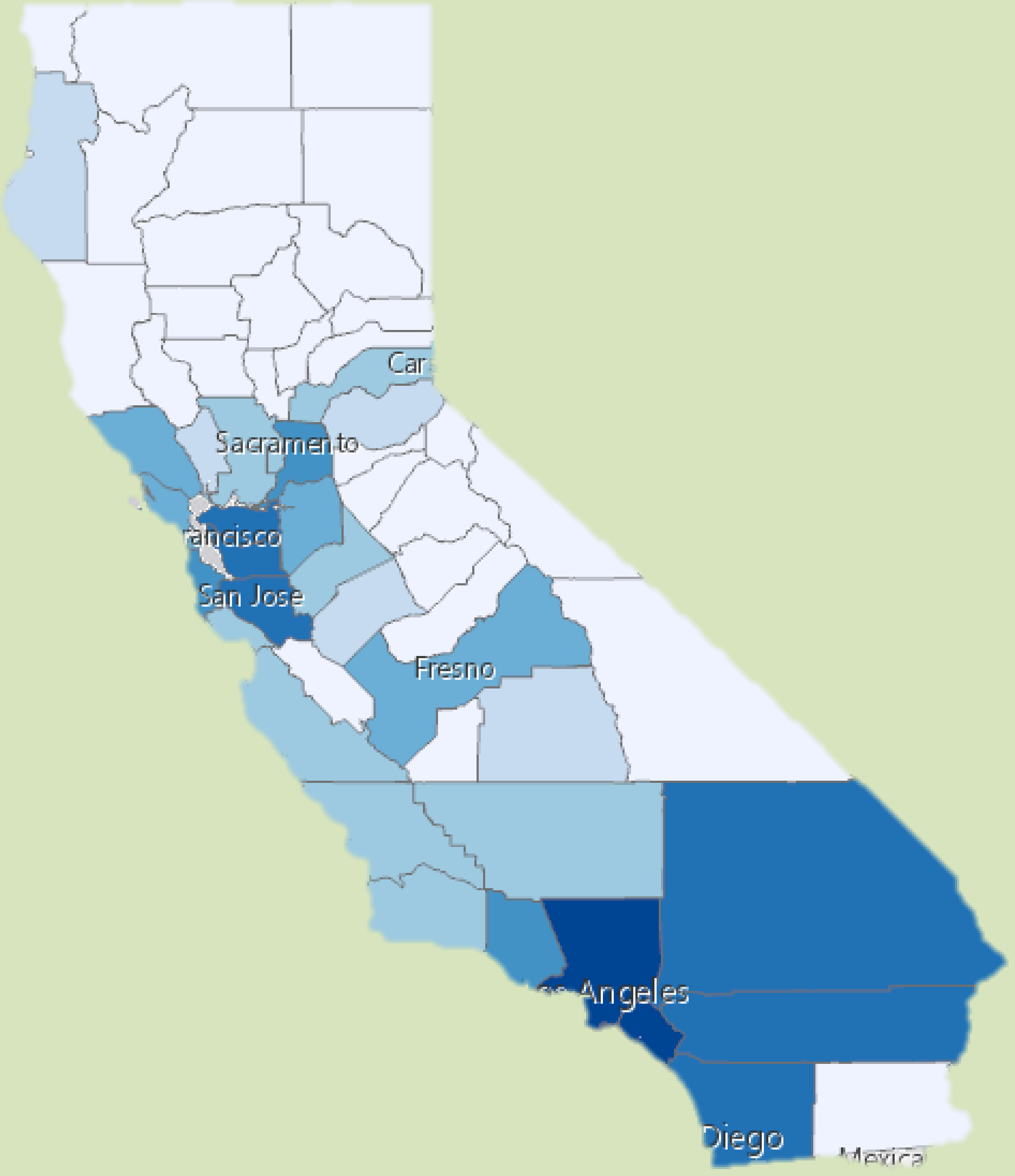
Clean vehicle Alternatives

Problem:
Clean Alternatives are Expensive



- Credits
- Discounts
- Tax reductions
- Rebates

CALIFORNIA
CLEAN VEHICLE REBATE PROJECT℠



What Types of Data We Used?

Data Sources

Issued Rebates for BEV and PHEV
2012 – 2023
From:

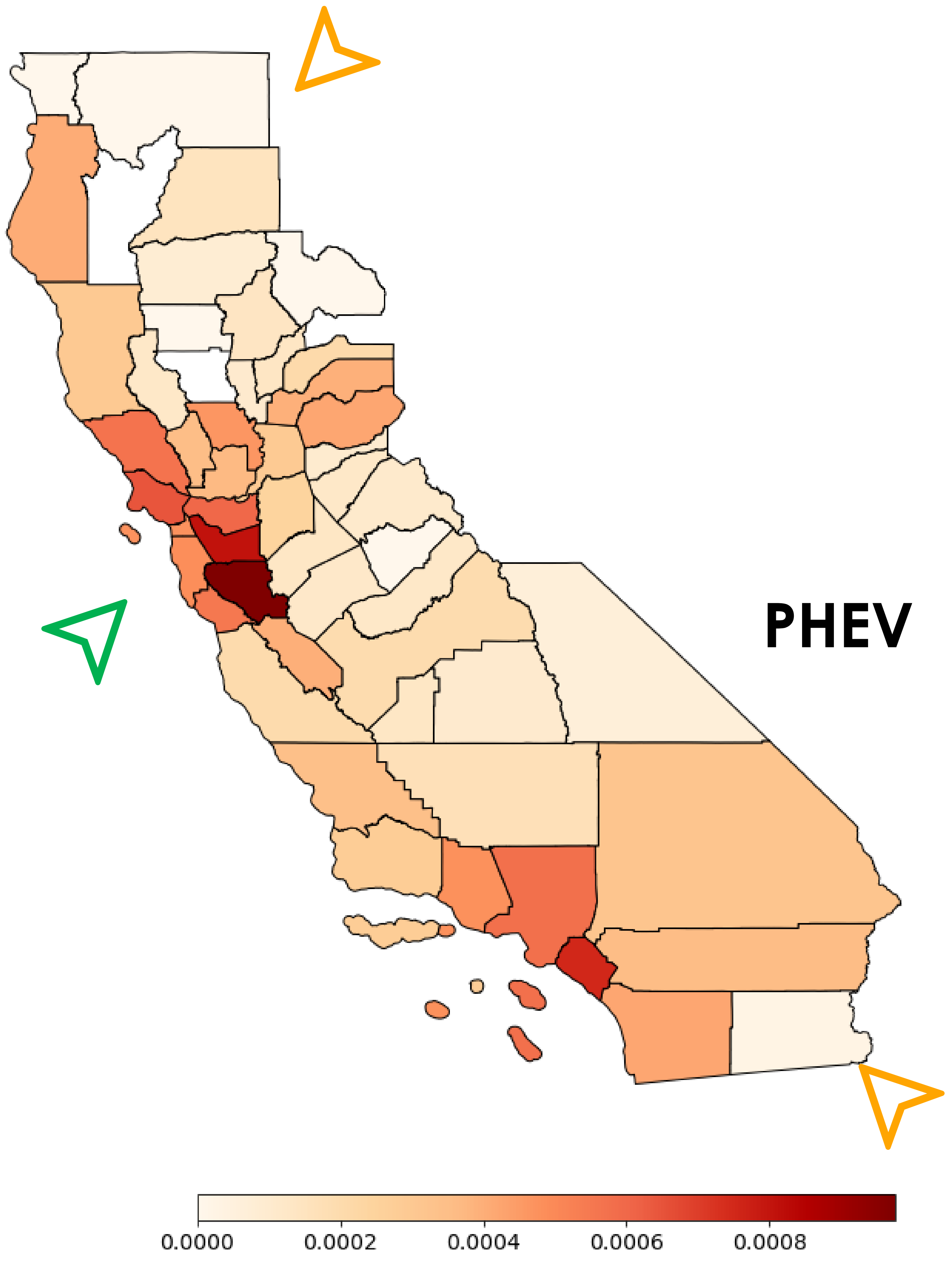
CALIFORNIA
CLEAN VEHICLE
REBATE PROJECT[SM]

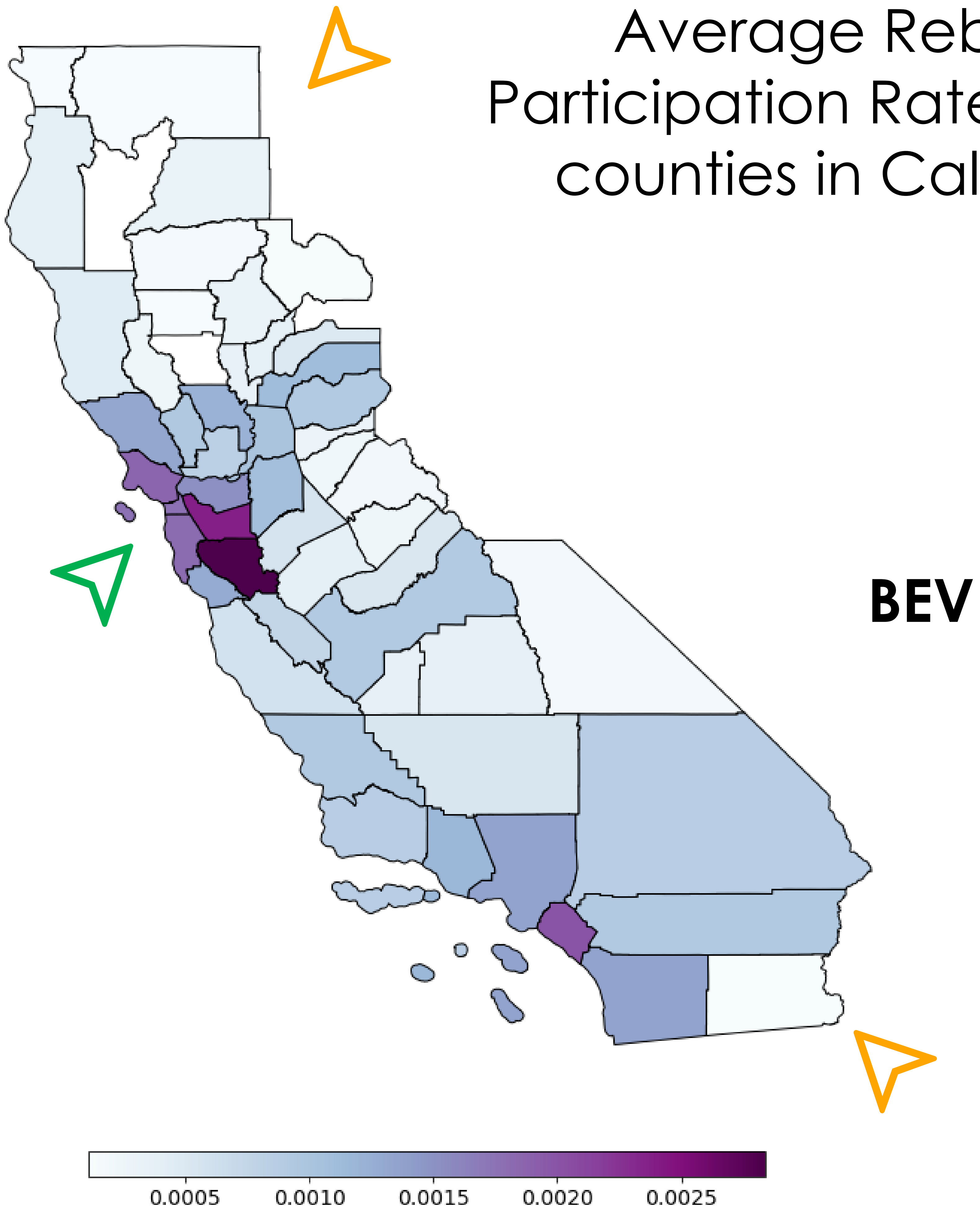
Rebate Participation Rate

Aggregated for each **county** in each **year**

Total registered vehicles

Average Rebate Participation Rates across counties in California





Data Sources

Age, Gender, Education, Race and ethnicity, Nationality, Household structure, Language

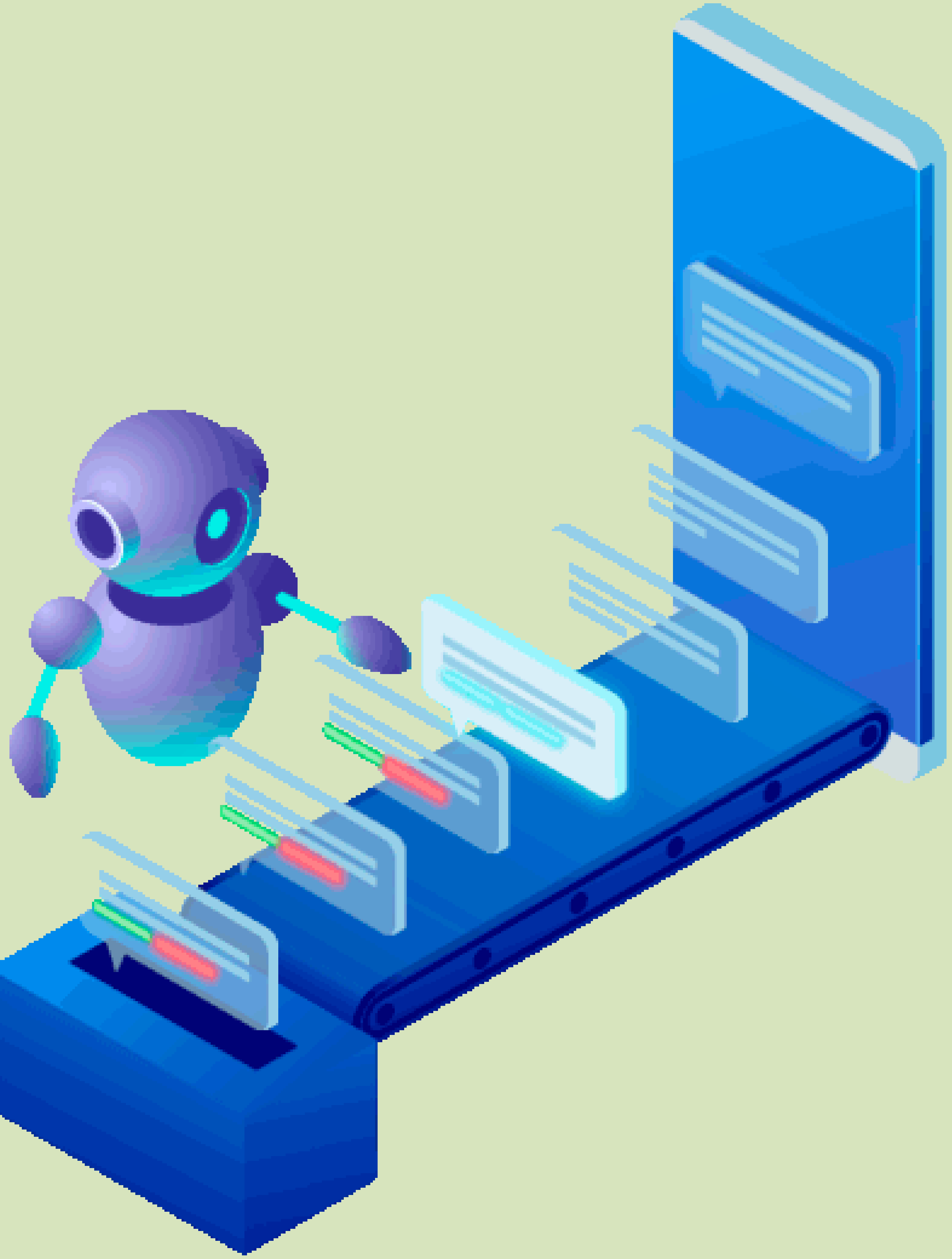
% of Urban and Built-Up, Farmland, Agricultural, Water

Gross Domestic Product (GDP), Income, Labor Force Participation, Employment rate

Public transit service and operation

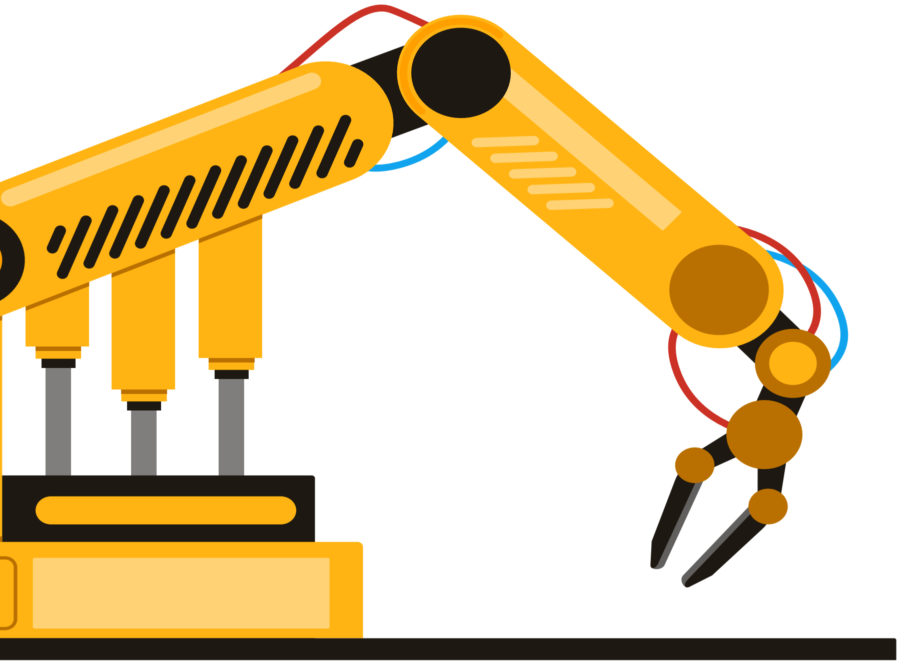
Number of EV charging stations

What Was the Analysis Approach?



Phase One

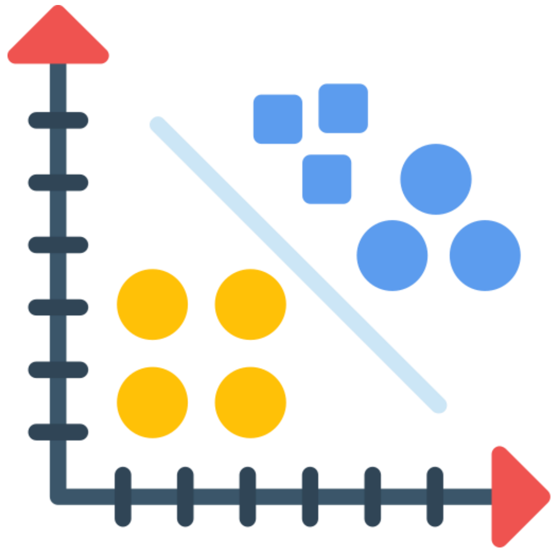
To understand rebate participation patterns in different context and locations

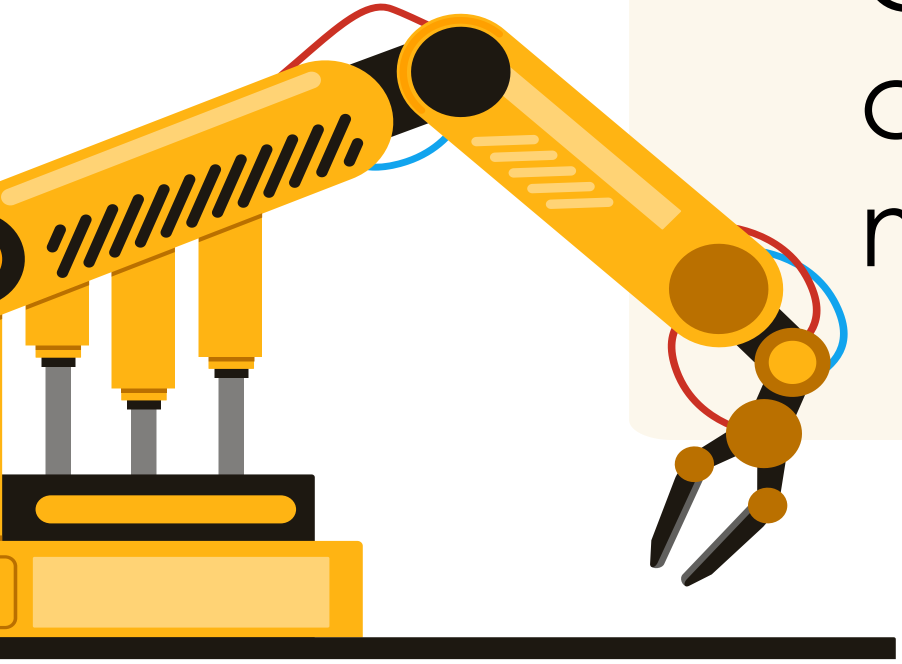


Phase One

- Applied **Dynamic Time Warping (DTW)** to capture temporal patterns in rebate participation.

- Grouped counties using **K-Means** clustering, an unsupervised learning method to identify adoption trajectories.





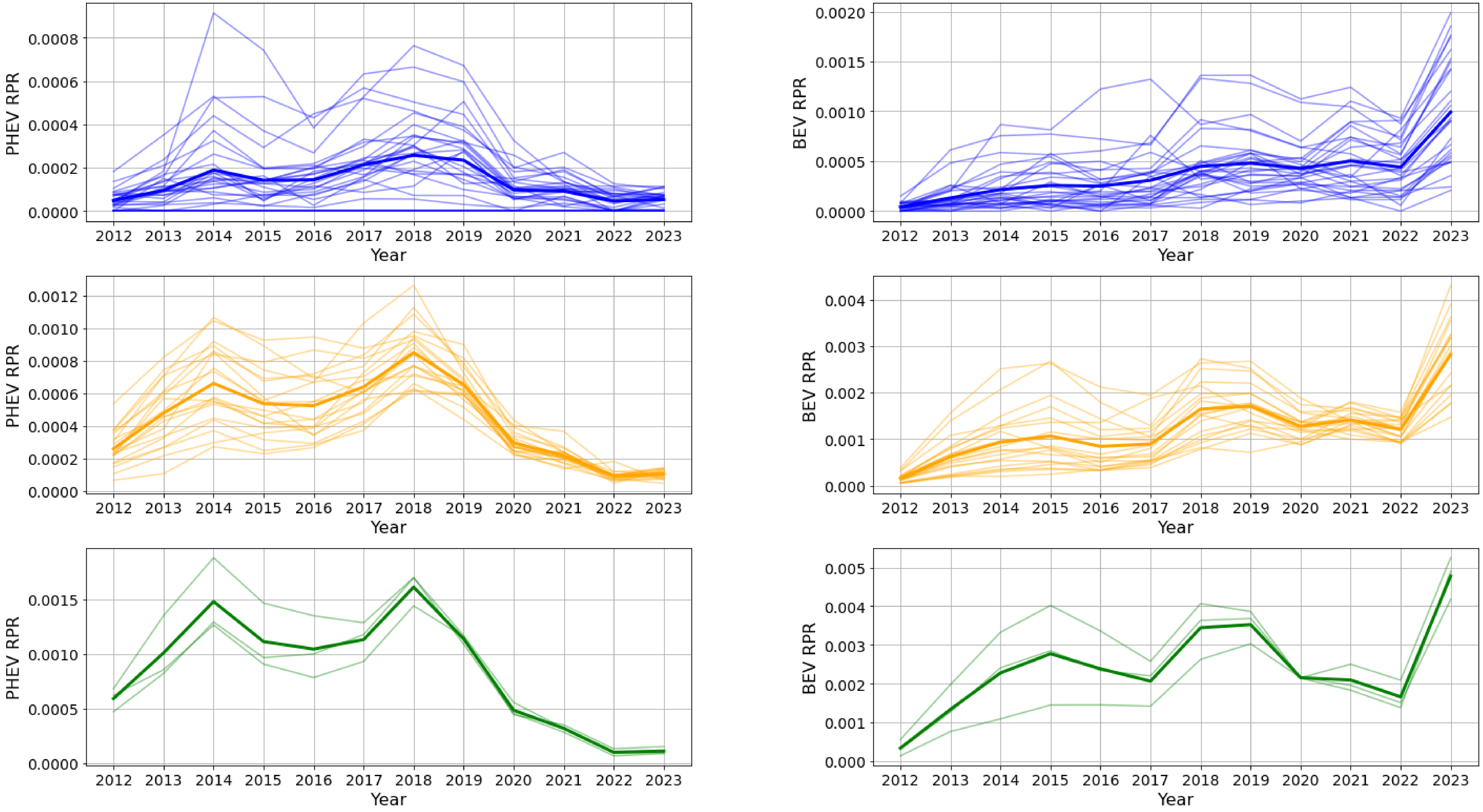
What did we find?

Yearly Average **Rebate Participation Rates**

Cluster 1

Cluster 2

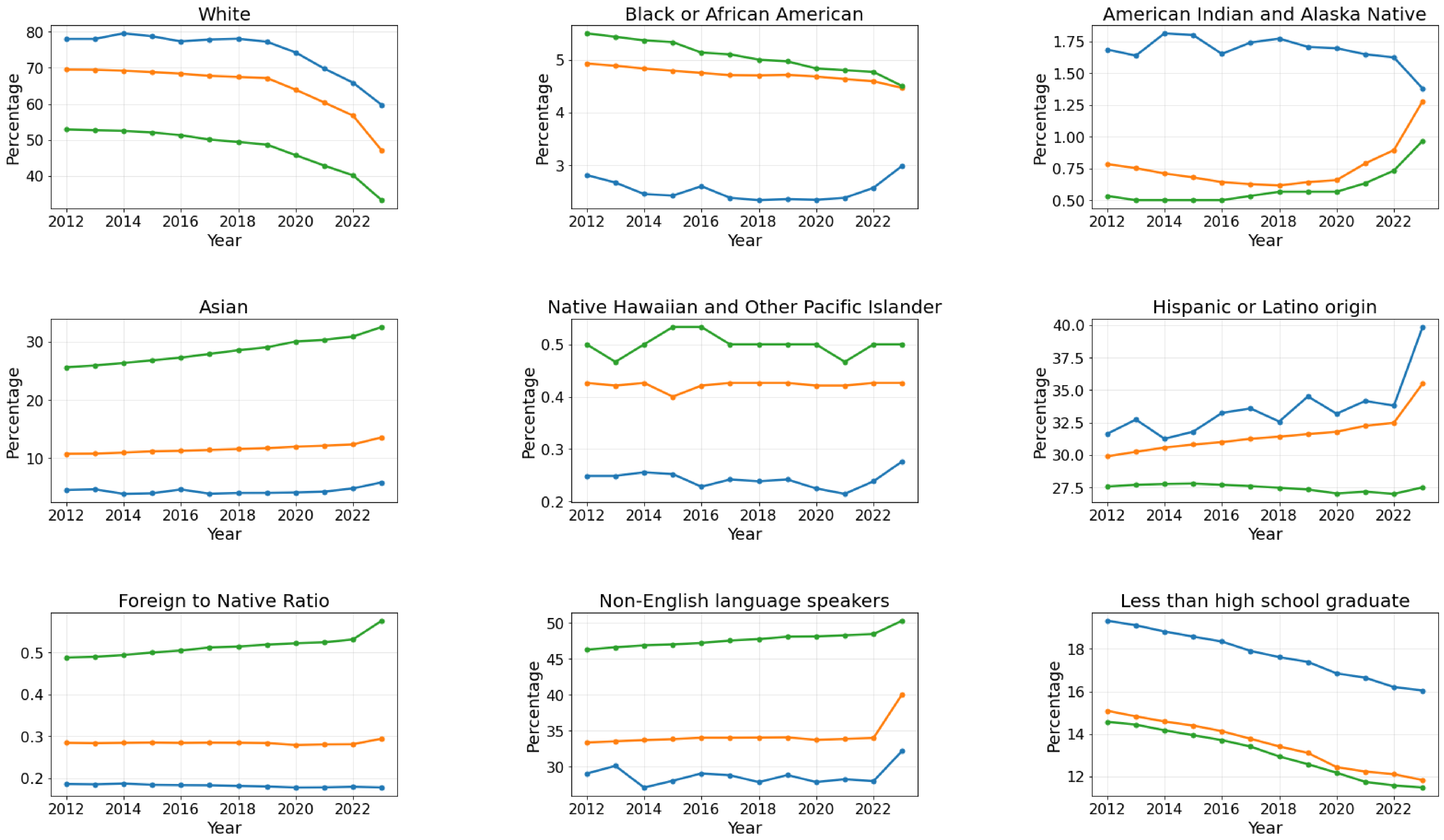
Cluster 3



PHEV

BEV

Demographic Factors



Cluster 1 Cluster 2 Cluster 3

Demographic Factors

Cluster 1

- Less diversity
- Older population
- lower educated people

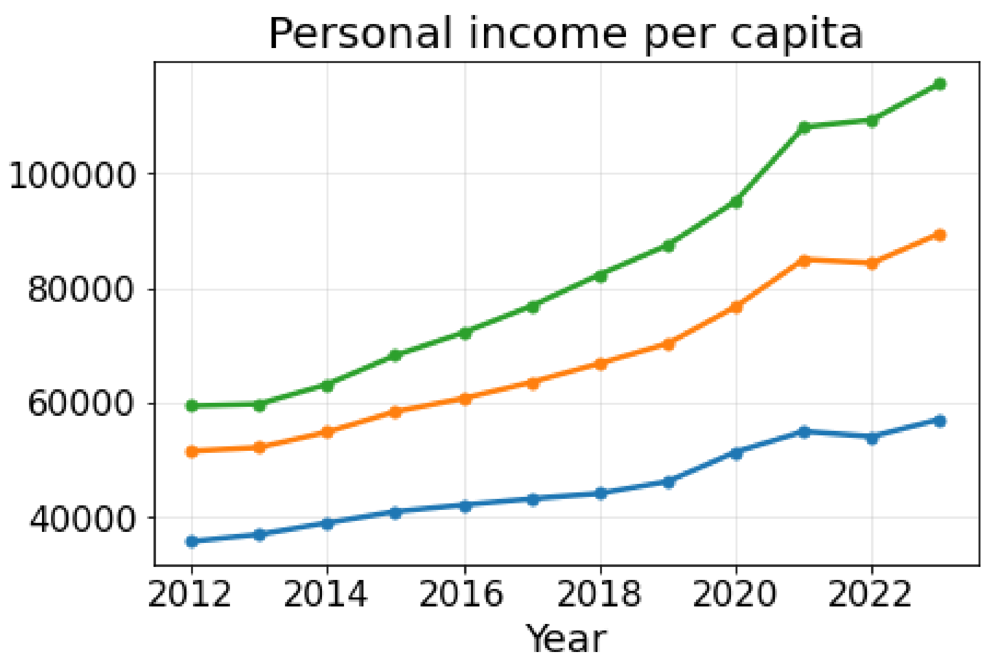
Cluster 2

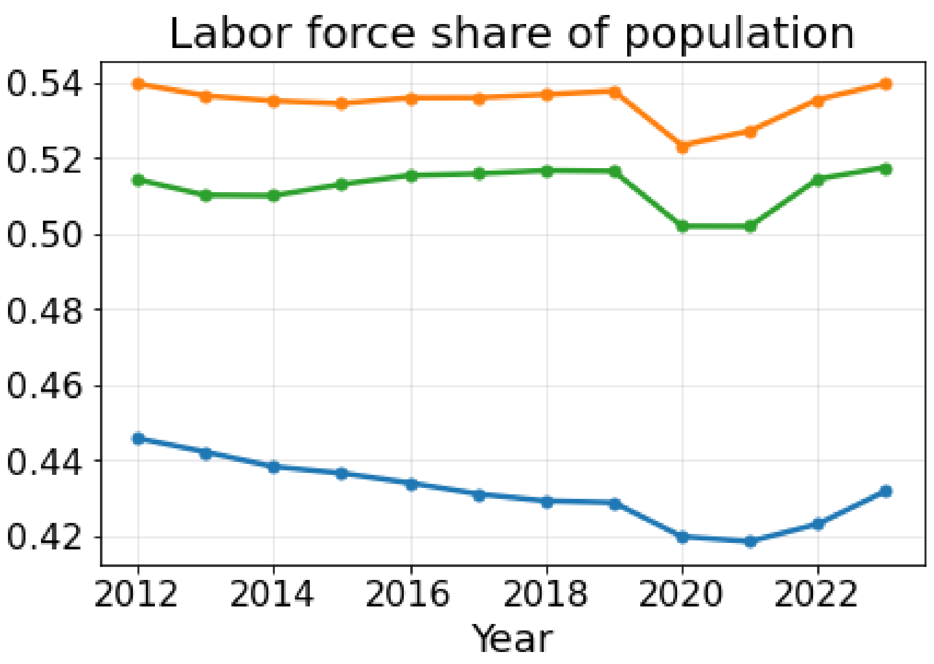
- In between

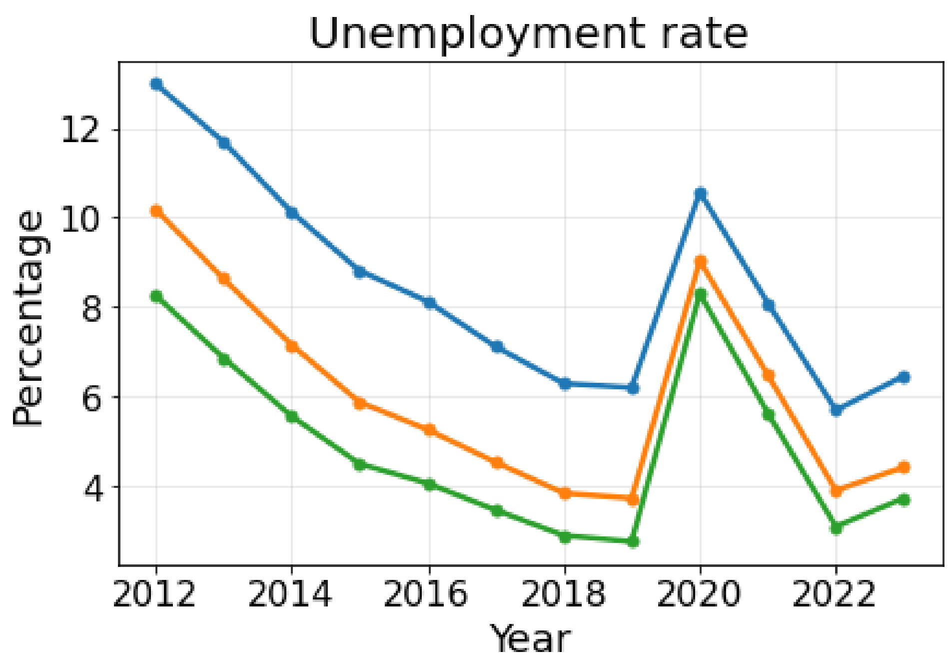
Cluster 3

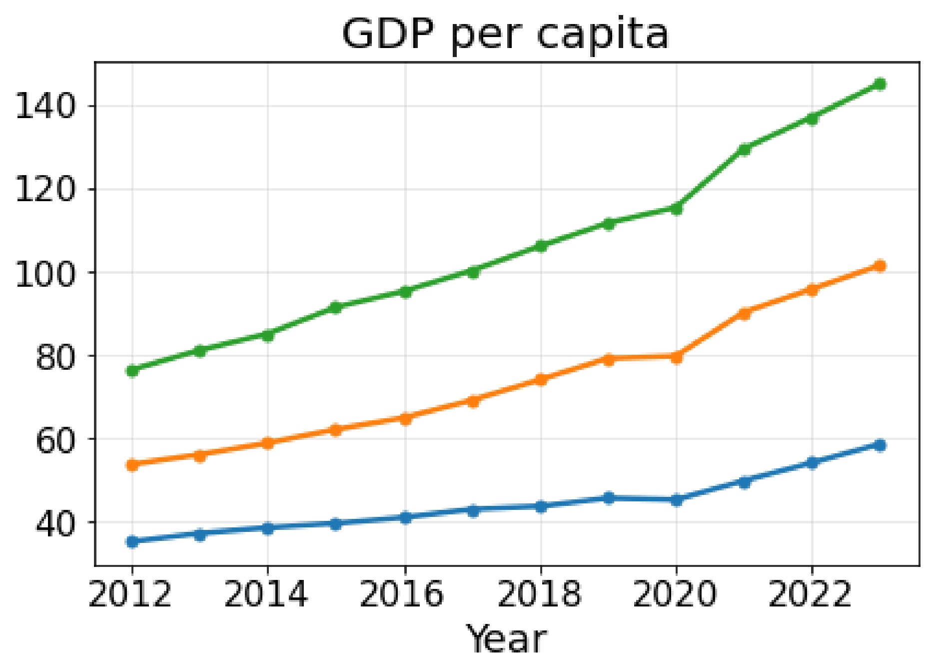
- High diversity
- Younger population
- Higher educated people

Economic Factors









Cluster 1 Cluster 2 Cluster 3

Demographic Factors

Cluster 1

- Low personal income and GDP
- Small labor force participation
- Highest unemployment rate

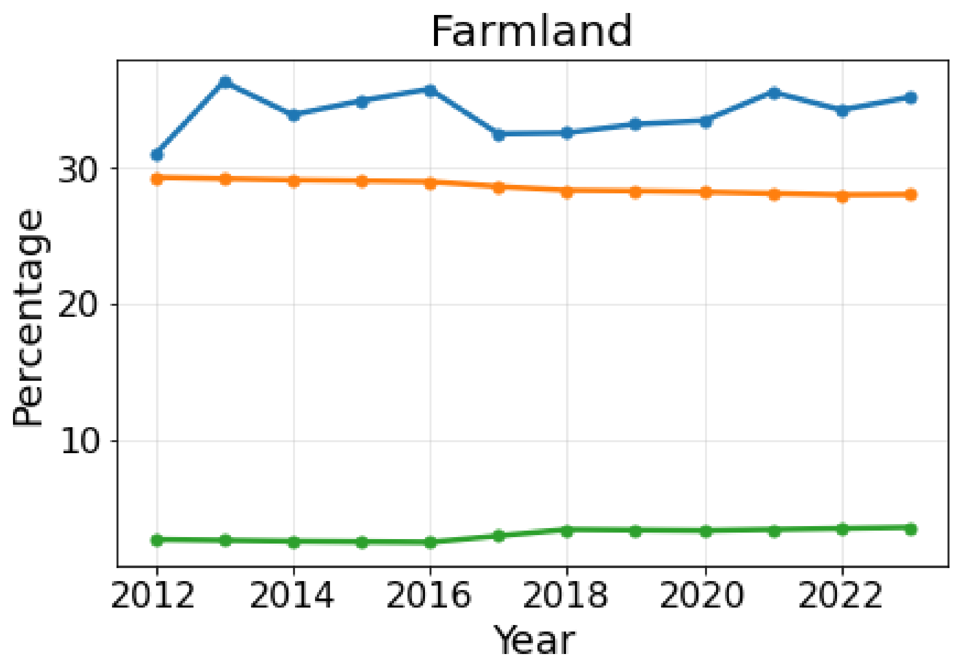
Cluster 2

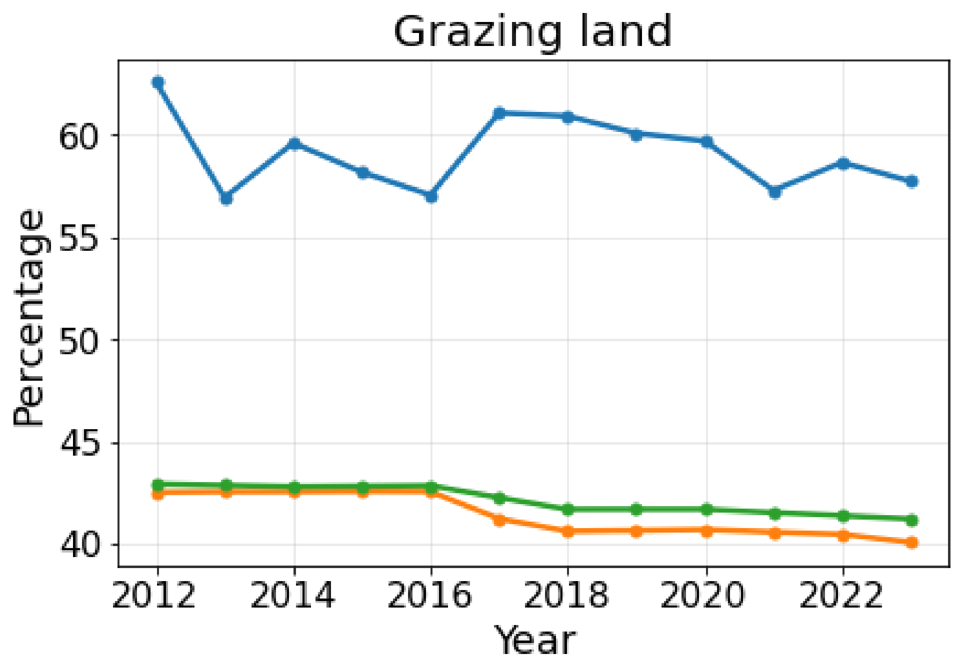
- In between

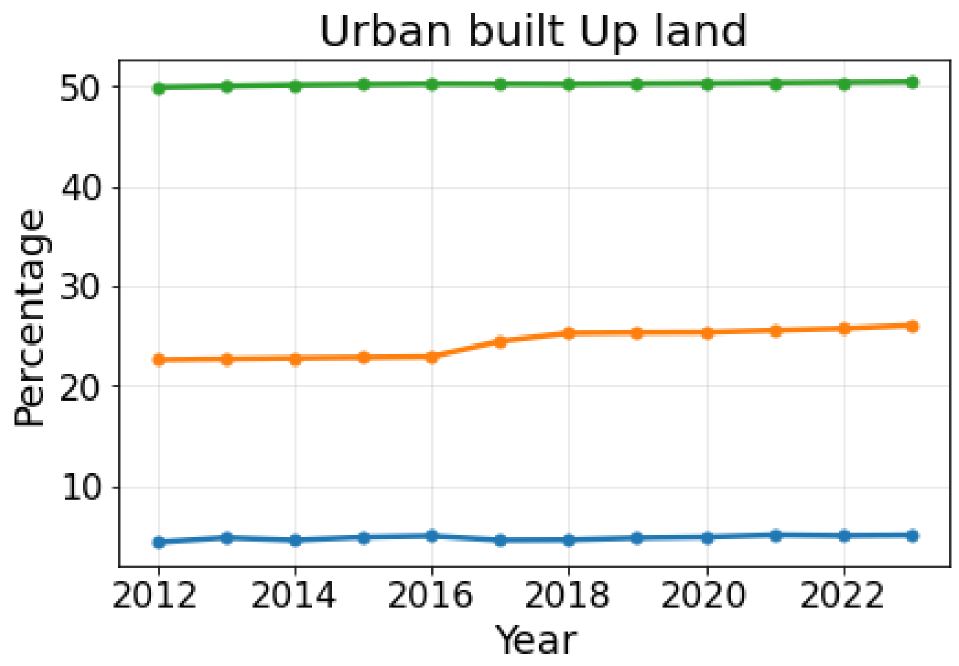
Cluster 3

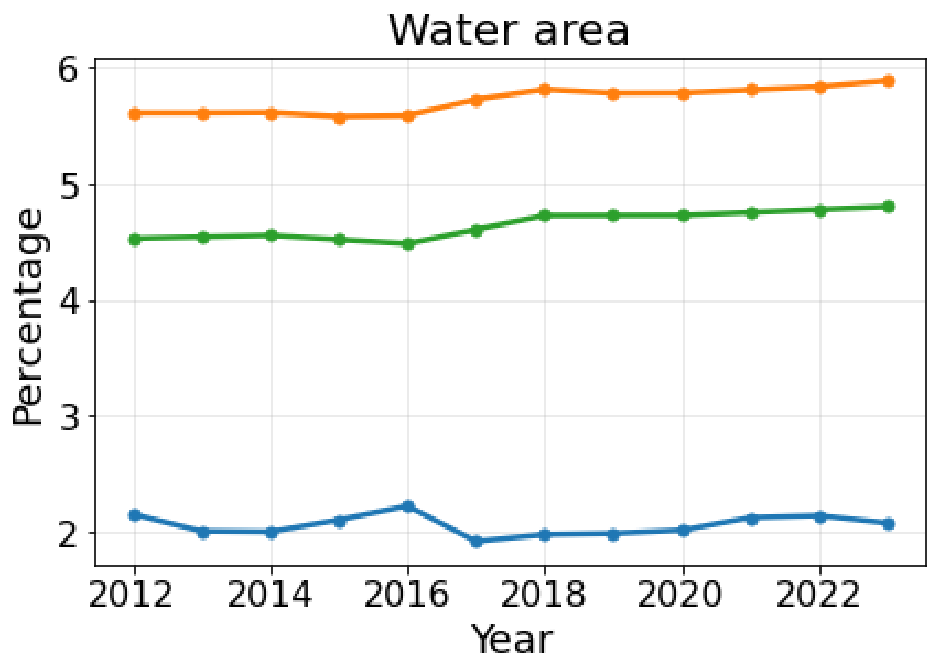
- High personal income and GDP
- Large labor force participation
- Lowest unemployment rate

Land-Use Factors









Cluster 1 Cluster 2 Cluster 3

Land-Use Factors

Cluster 1

- **The most rural with large % of agricultural and farmland**

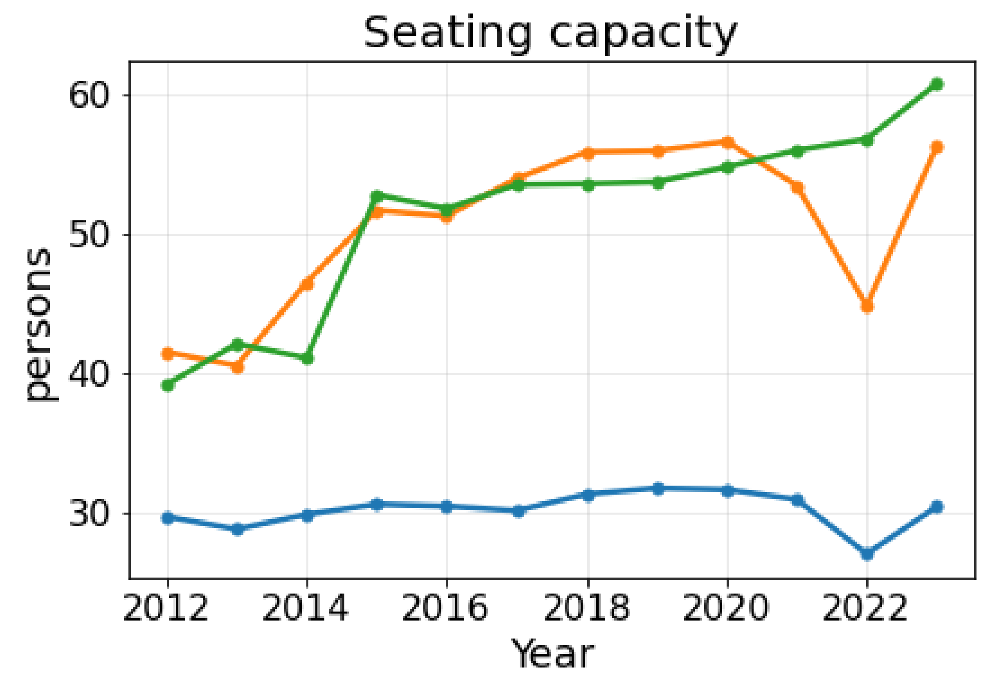
Cluster 2

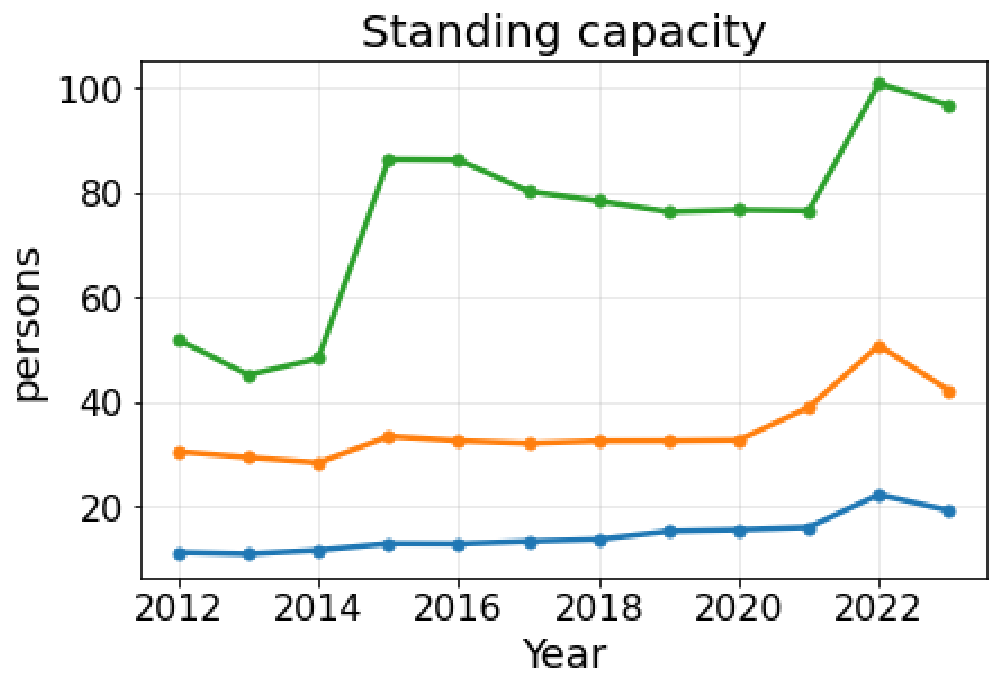
- **In between, suburb**

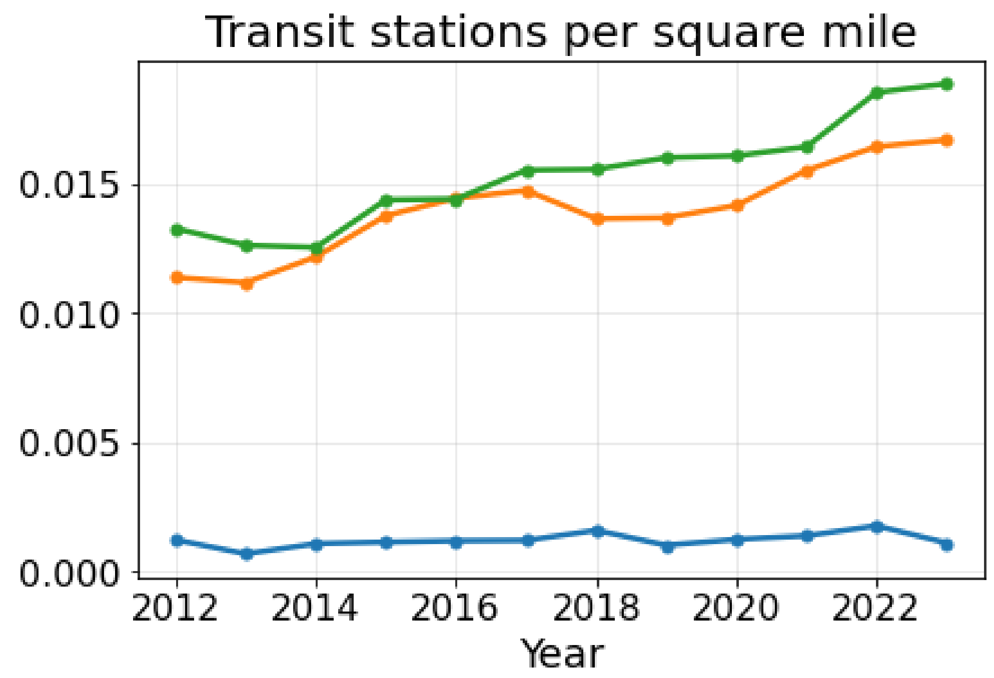
Cluster 3

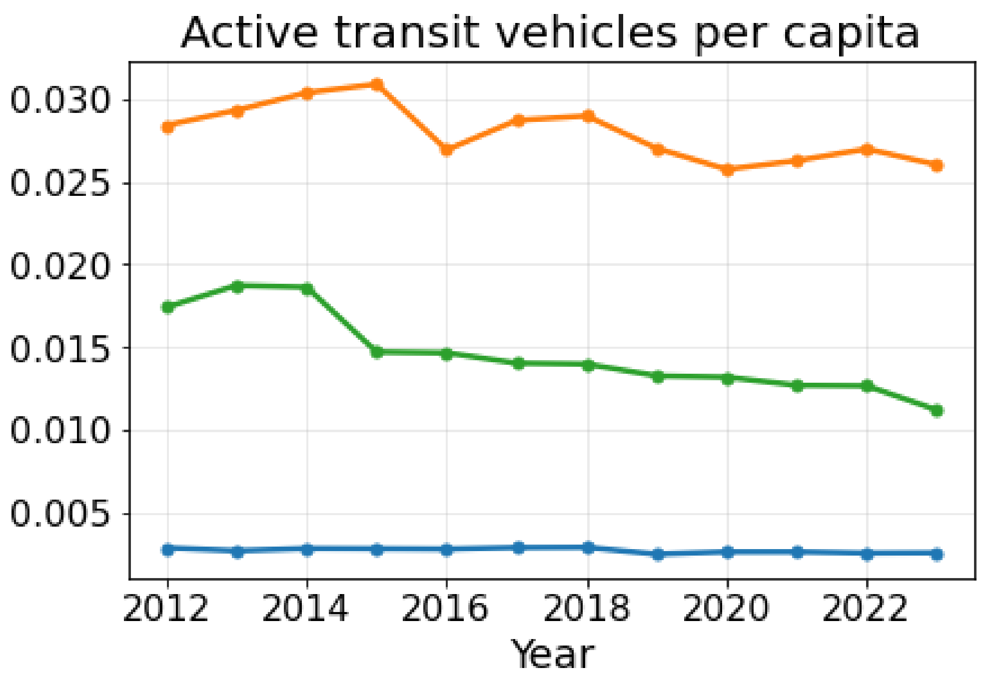
- **The most urban with large % of developed and built-up land**

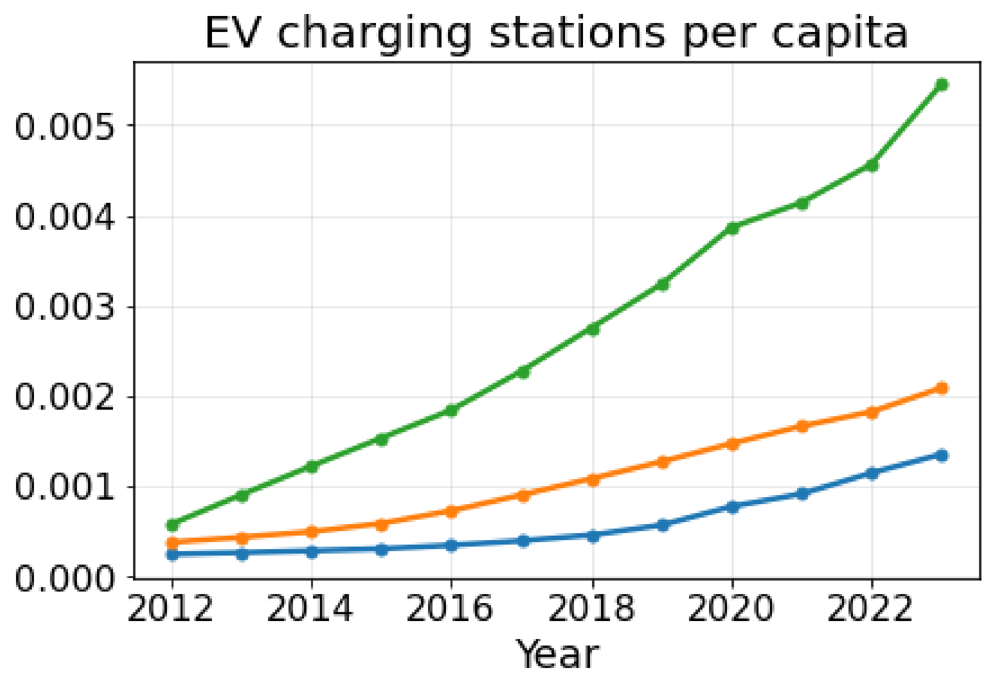
Infrastructural Factors











Cluster 1 ● **Cluster 2** ● **Cluster 3** ●

Infrastructural Factors

Cluster 1

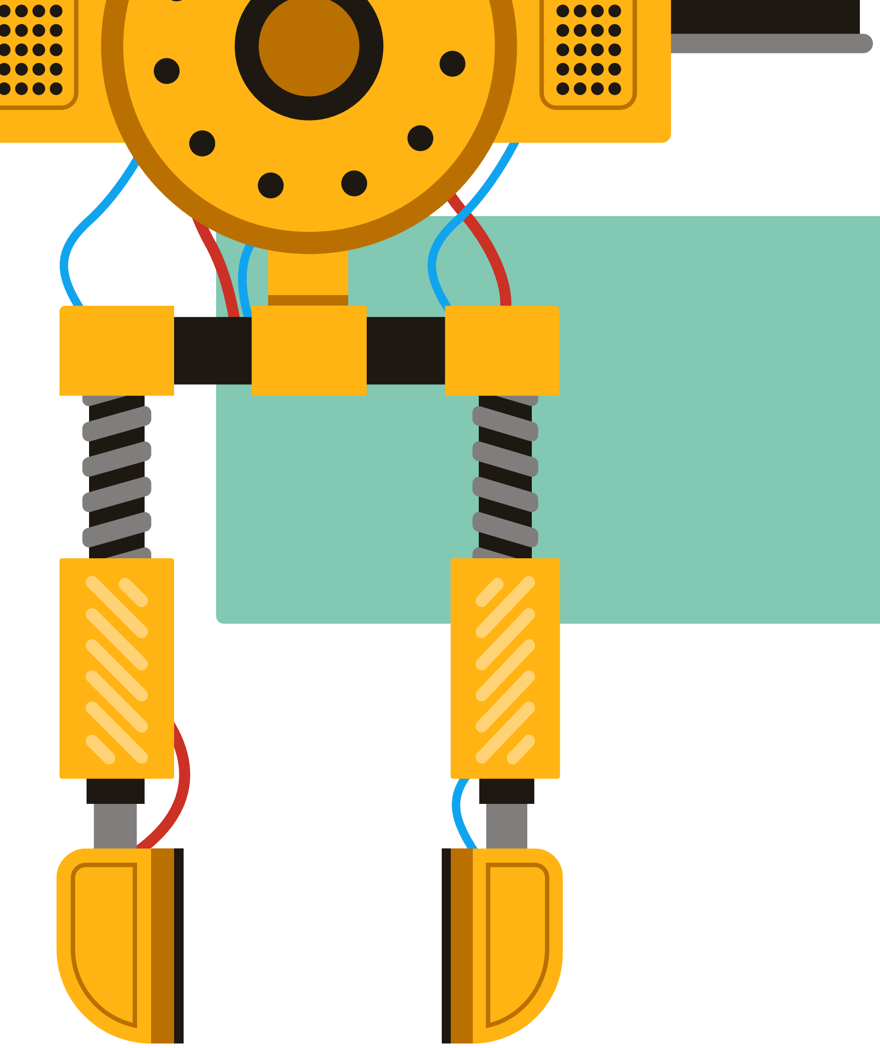
- Few charging stations and low-capacity transit network

Cluster 2

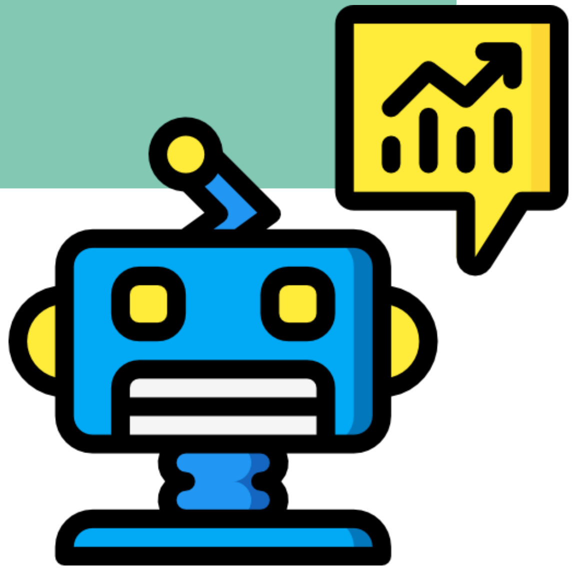
- In between

Cluster 3

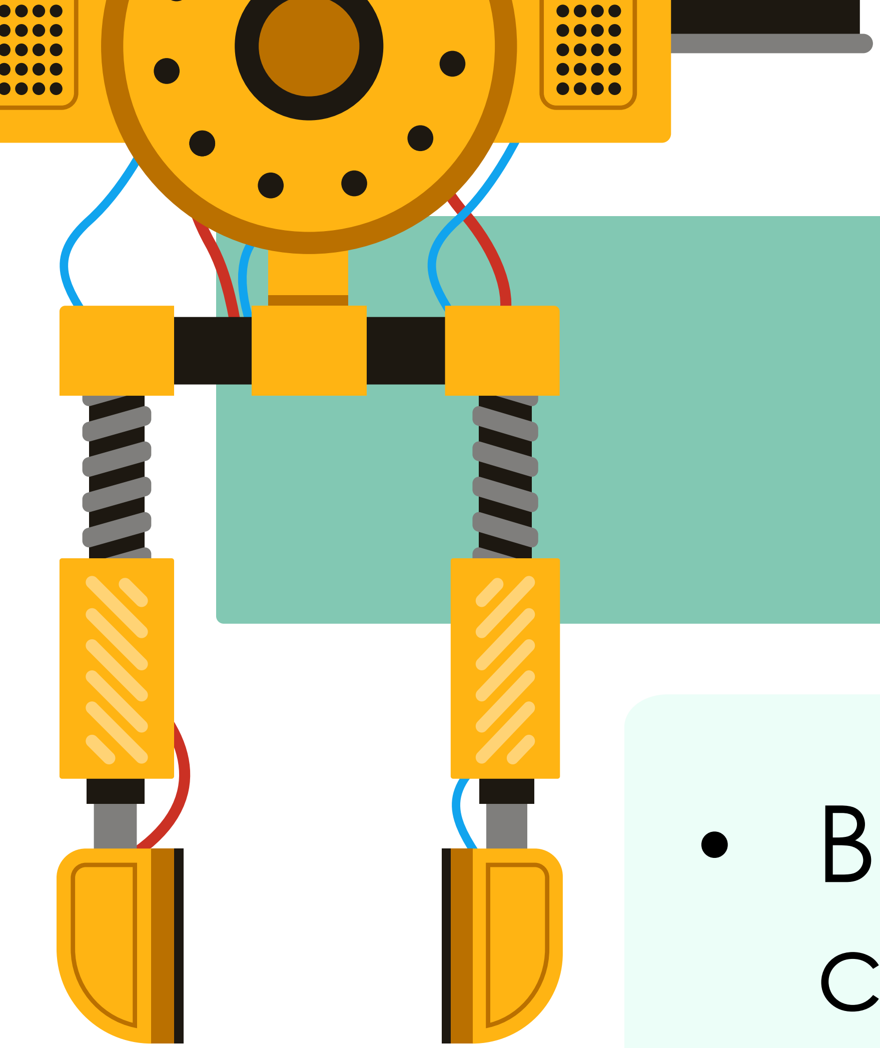
- The best transportation infrastructure, well developed transit network with high charging station number



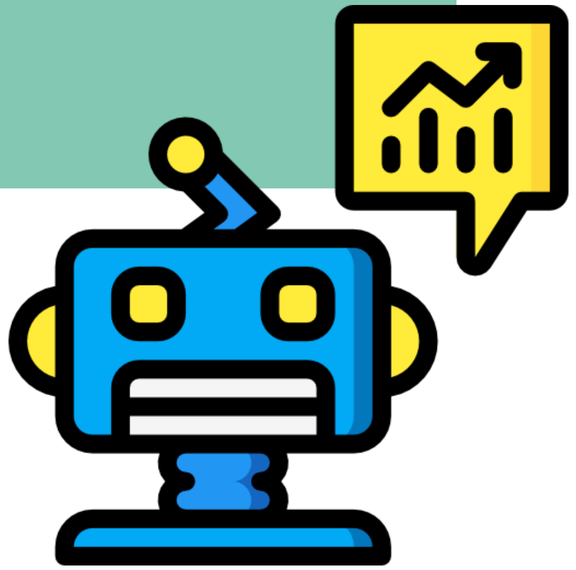
Phase Two



To predict county level rebate participation with historical data



Phase Two



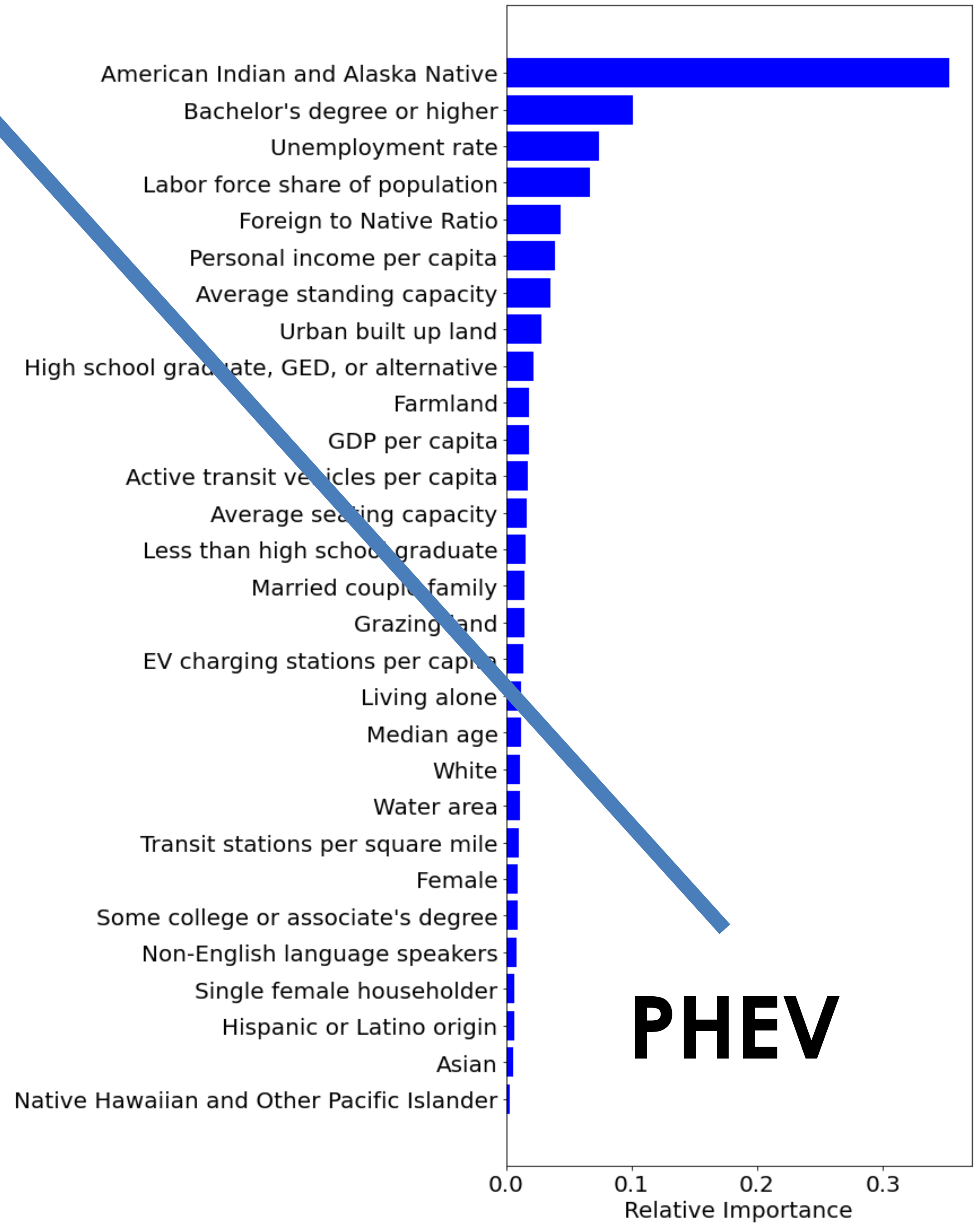
- Built **Random Forest** model to predict county-level rebate participation.
- Incorporated demographic, economic, land use, and infrastructural features.

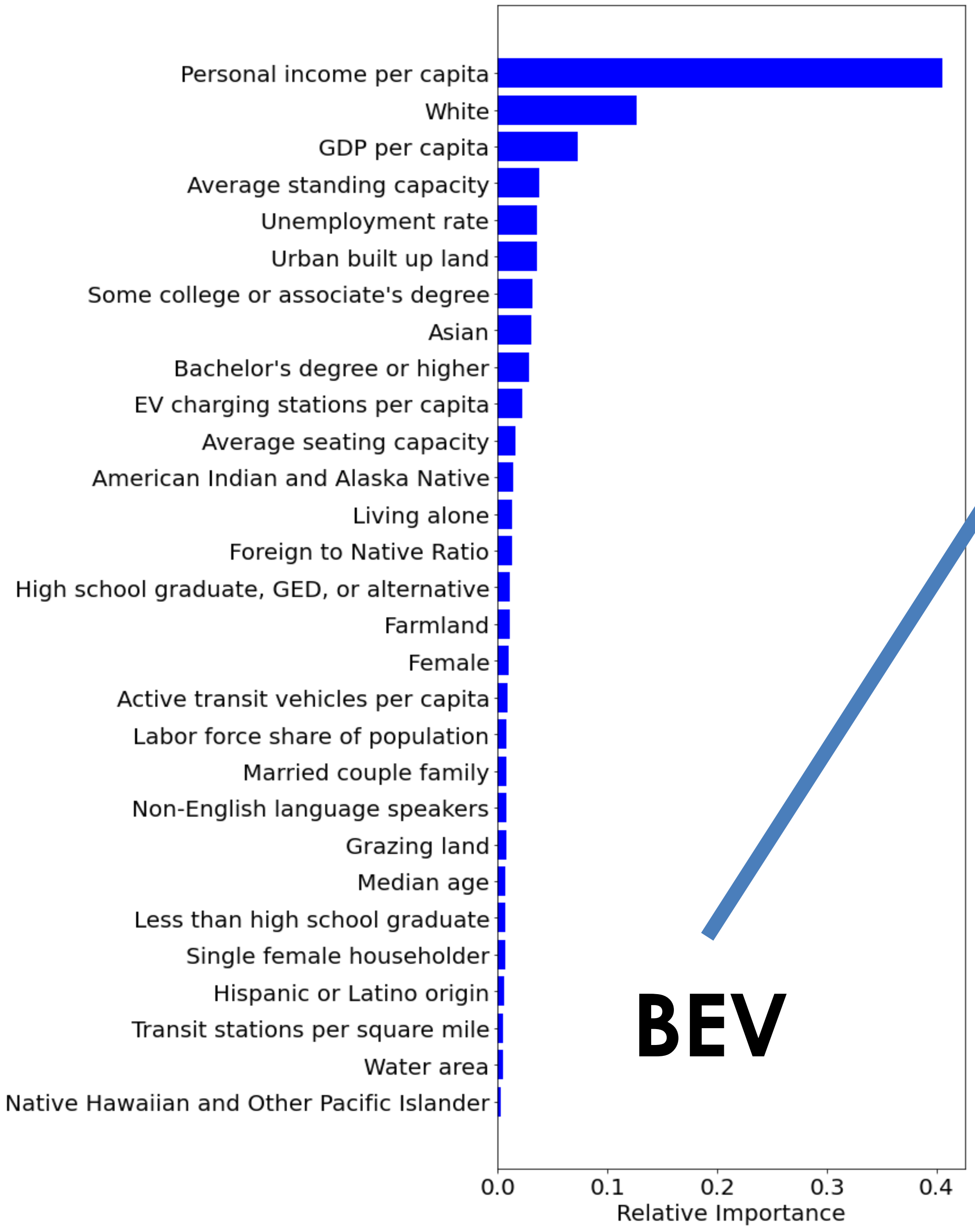
What did we find?

Random Forest Model Results

- **Accuracy:** 78%
- **Influencing factors**: demographic factors such as race, foreign-born share, and education

- **Accuracy**: 82%
- **Influencing factors**: income and GDP, developed land, and transportation infrastructure





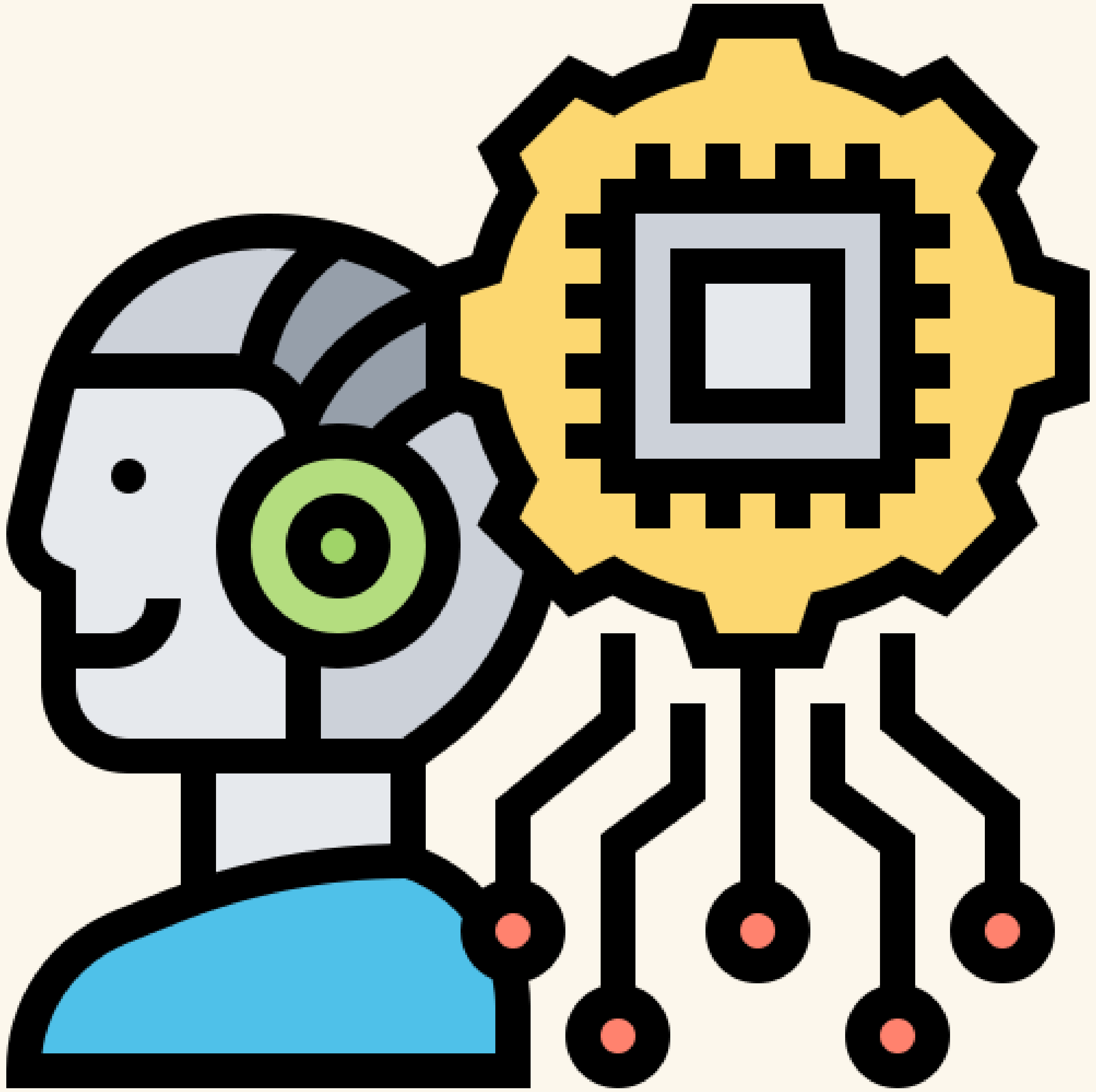
Conclusion

Counties show distinct EV rebate participation patterns over time.

Higher adoption is tied to stronger economies, higher education, racial diversity, and urban infrastructure.

Rural, older, and lower-income counties face persistent barriers despite rebates.

Targeted infrastructure, financial support, and outreach are more effective than uniform statewide incentives.



Study Importance

Shows how advanced techniques can **guide more targeted, data-driven policy planning** beyond uniform statewide approaches.

Next steps

Integrate post-2023 data to capture the influence of emerging technologies, policies, and funding structures on EV adoption

Thank you!

Questions?

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