Characterized Adoption Rate of Electric Vehicles in California

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EV Adoption Rate in CA

We will be analyzing data for:

- The EV adoption rate in Urban vs Rural Areas
- Adoption rate across different income neighborhoods
- Changes in adoption rate by county, compared to other fuel sources
- Changes in the number of EV charging stations
- Changes to EV adoption rate as gas prices increase

Data Sources



Population, Income and Geographic Data for CA



Vehicle Fuel Type Count by Zip Code for 2020-2022



Electric Vehicle Chargers in California



U.S. Energy Information Administration (EIA)

Tools: Pandas, Matplotlib, Numpy

Data Processing



US Census Data Collection

- American Community Survey 5 was source
- API calls for ZIP and County
- Population, Household Income and Year were the variables
- Used a Extrapolated data for 2023 since census only runs to 2022
 - Assumed average change by zip and by county for the preceding four years would continue for 2023
- Merged dataset with physical area in square miles to allow population density calc
- Employed quartiles to Household Income to define income levels

Cleanup and Aggregation

- Dropped '0' population rows
- Dropped zip codes with negative household incomes
- Removed data where county was NA
- Removed any rows where there were less than four years of data due to prior drops
- Merged w/ DMV registration records
- Aggregated for analysis and visualization
 - Urban vs Rural = > 1,000/sq mi
 - Determined DMV registrations per 100,000 population by county and for the state

Data Sources (cont'd)



	County	Year	Population	Household Income	Area (sq mi)	Density
0	Alameda	2018	1643700.0	92574.0	737.57	2228.534241
1	Alameda	2019	1656754.0	99406.0	737.57	2246.232900
2	Alameda	2020	1661584.0	104888.0	737.57	2252.781431
3	Alameda	2021	1673133.0	112017.0	737.57	2268.439606
4	Alameda	2022	1663823.0	122488.0	737.57	2255.817075
343	Yuba	2019	76360.0	58054.0	630.69	121.073745
344	Yuba	2020	77524.0	59424.0	630.69	122.919342
345	Yuba	2021	80404.0	62666.0	630.69	127.485770
346	Yuba	2022	81705.0	66693.0	630.69	129.548590
347	Yuba	2023	83258.0	70210.0	630.69	132.010972



	County	Year	Vehicles per 100K
0	Alameda	2020	261.196545
1	Alameda	2021	283.898530
2	Alameda	2022	335.372212
18	Contra Costa	2020	212.147191
19	Contra Costa	2021	240.177060
20	Contra Costa	2022	289.855571
54	Los Angeles	2020	183.304282
55	Los Angeles	2021	204.448565

Data Processing



CA DMV Data Collection

 CSV Files for 2020, 2021, and 2022 for "Vehicle Fuel Type Count by Zip Code"

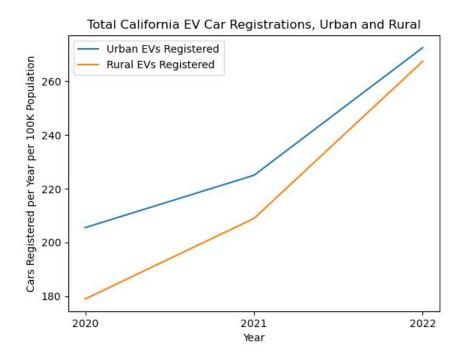
Cleanup and Aggregation

- Merged CSV files for all three years
- Dropped 'Model Year', 'Make', and 'Duty'
- Merged DMV data with US Census data to obtain county information
- Removed any "OOS" Zip Code data
- Grouped data by Fuel Type, Year, and Vehicle Count per fuel type
- Grouped data for Battery Electric Vehicles only by county, per year

Date	Zip Code	Model Year	Fuel	Make	Duty	Vehicles
1/1/2020	90001	2007	Gasoline	ACURA	Light	15
1/1/2020	90002	2007	Gasoline	ACURA	Light	20
1/1/2020	90003	2007	Gasoline	ACURA	Light	29
1/1/2020	90004	2007	Gasoline	ACURA	Light	19
1/1/2020	90006	2007	Gasoline	ACURA	Light	15
1/1/2020	90011	2007	Gasoline	ACURA	Light	36

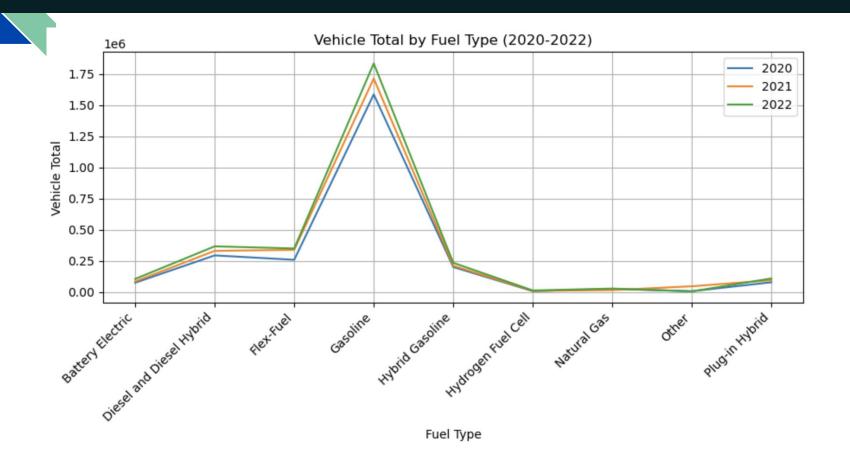
county	Fuel	Year	Vehicles
Alpine	Battery Electric	2020	5
Alpine	Battery Electric	2021	15
Alpine	Battery Electric	2022	30
Amador	Battery Electric	2020	130
Amador	Battery Electric	2021	185

Urban vs. Rural Areas

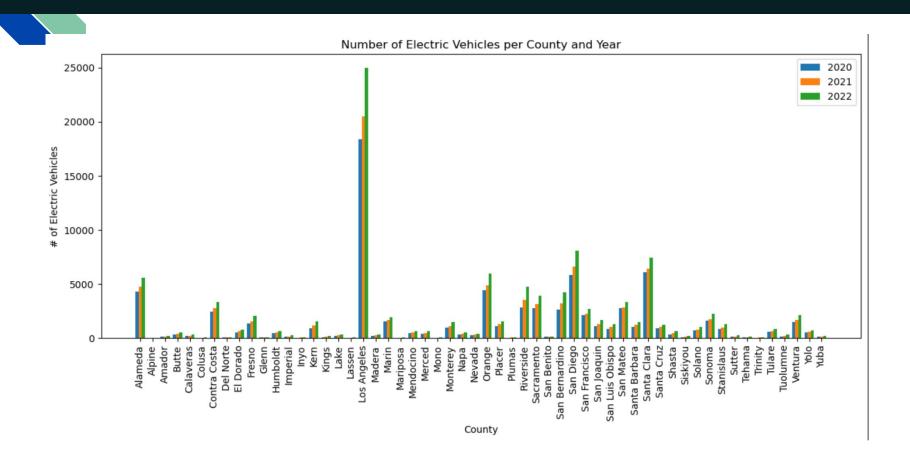


- Adoption rates between urban and rural areas across are very similar based on DMV registrations of EV's
- Over the past 3 years, the difference between urban counties and rural counties averages just 7% and is narrowing
- While this was an unexpected result, it matches up well with our analysis that shows build-out of charging infrastructure matching closely with EV sales by county

Fuel Type Comparison



EVs Per County

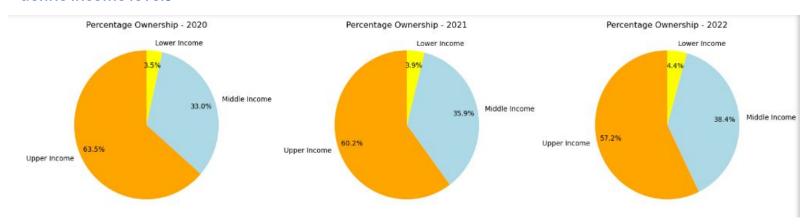


EV Ownership per Income Levels

- Two sets of data
 - DMV: Zip Codes and EV registrations
 - Census: Zip Codes and Household Income
- DMV: EV registrations per neighborhood (i.e., zip code) per year
- Census: Household income per neighborhood per year
 - 25% and 75% quartiles of household income define boundaries of high and lower income levels
- Obtained EVs registrations of high, middle, and low income neighborhoods
- Applied to statewide registrations to find EV percentages
- Visualizations of EV registrations for high-, middle-, and low- incomes were generated

Percentage Ownership per Income Levels

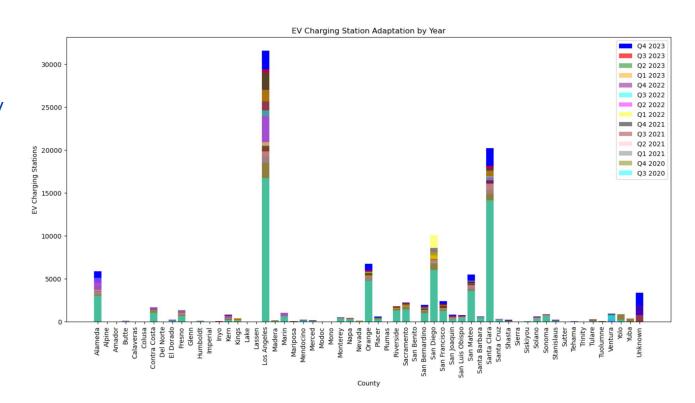
Employed quartiles to define income levels



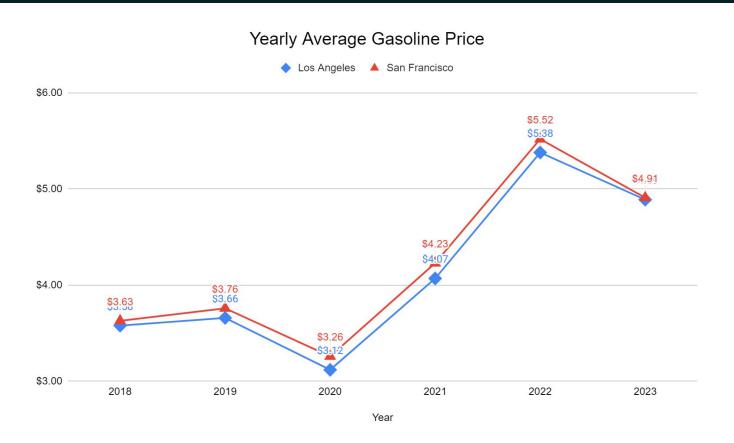
- More than 50% of EVs were registered with upper-income households
- Lower- and middle-income households show a year-over-year percentage gain

Charging Stations

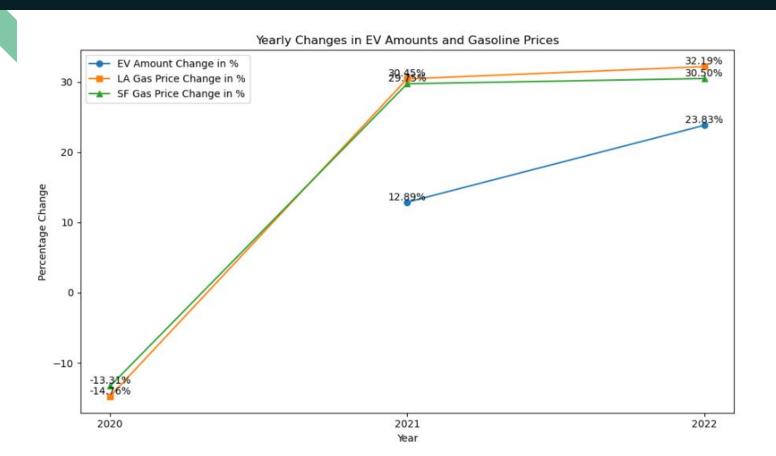
Closely mirrors the total EV DMV registrations by county



Yearly Average Gasoline Price



Gasoline Price Change VS EV Amounts Change



Summary

- Expected EV adoption to be much higher in rural areas than urban, but that was not the case
- Expected EV adoption to be higher in the top quartile of household income, but did not expect a widening gap between lower income level with middleand upper-income levels
- Gasoline is still, by a wide margin, the dominant fuel source for personal vehicles in California
- Buildup in EV infrastructure (public charging stations) appears to be at just as high a rate in rural counties as in urban, which may explain why adoption rates in rural counties are nearly as high as in urban
- There is a strong correlation between the rate of increase in gasoline prices and the rate of increase in EV ownership with similar growth rates in each from 2020 to 2022

Challenges and Next Steps

- Challenges
 - Some data sets available just by region, others by state, others by ZIP
 - Not all data sets available for the same years
 - Gasoline prices over time were only state wide
 - Geo classification of rural vs urban is somewhat imprecise; census uses a combination of density and nearby urban areas that won't map to counties

- Next Steps: The analysis resulted our thinking up additional questions...
 - Is grid capacity keeping up?
 - What about plug in hybrids and fuel cell vehicles?
 - Why are DMV registrations increasing overall when population is shrinking slightly?