Analysis of Solar Energy Installations and Electric Vehicle Trends

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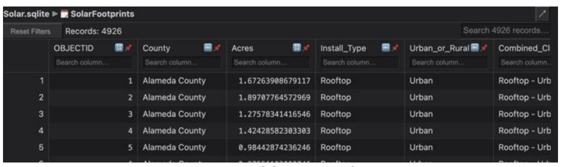
The global shift toward sustainable energy solutions has placed solar energy and electric vehicles (EVs) to the forefront of modern energy regulations. In order to examine their interdependencies and offer useful information for energy planning in both urban and rural areas, this study looks into the adoption trends of solar energy installations and electric vehicle registrations. We find trends, correlations, and important factors influencing adoption in both urban and rural areas by examining two extensive datasets: data on solar energy installations and data on electric car registrations. The study finds that large-scale solar farms in rural areas and rooftop solar installations in urban areas have complementing connections with EV adoption. The recommendations for energy policies that close the gap between urban and rural areas and promote a cohesive, sustainable energy ecosystem are based on this investigation.

I. QUESTION

In what ways do electric car registrations and solar energy installation trends complement one another in rural and urban areas?

II. DATA SOURCES

The dataset on solar energy is organized using continuous, categorical, and spatial variables. Location-based characteristics like county and urban/rural classification are examples of spatial variables. Installation type (e.g., rooftop or ground-based) and combined classifications (e.g., ground-rural) are examples of categorical variables. Installation size in acres and distance from substations are examples of continuous variables. High data quality for analysis is ensured by the dataset's organization and lack of missing values. [1]



Solar.sqlite ▶ SolarFootprints
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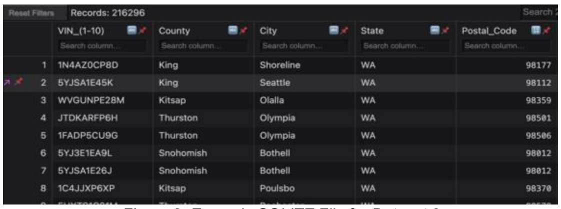
	OBJECTID	County	Acres	Install_Type	Urban_or_Rural	Combined_Cl
1	1	Alameda County	1.67263908679117	Rooftop	Urban	Rooftop - Urb
2	2	Alameda County	1.89707764572969	Rooftop	Urban	Rooftop - Urb
3	3	Alameda County	1.27578341416546	Rooftop	Urban	Rooftop - Urb
4	4	Alameda County	1.42428582303303	Rooftop	Urban	Rooftop - Urb
5	5	Alameda County	0.98442874236246	Rooftop	Urban	Rooftop - Urb

Figure 1: Example SQLITE File for Dataset 1

The dataset for electric vehicles has continuous, category, and geographical variables in a similar manner. City, county, and postal code are examples of location-based qualities that are considered spatial variables. Electric vehicle type (such as BEV or PHEV), make, and model year are examples of categorical variables. Electric range and base MSRP are examples of continuous variables. [2]



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	VIN_(1-10)	County	City	State	Postal_Code
1	1N4AZ0CP8D	King	Shoreline	WA	98177
2	5YJSA1E45K	King	Seattle	WA	98112
3	WVGUNPE28M	Kitsap	Olalla	WA	98359
4	JTDKARFP6H	Thurston	Olympia	WA	98501
5	1FADP5CU9G	Thurston	Olympia	WA	98506
6	5YJ3E1EA9L	Snohomish	Bothell	WA	98012
7	5YJSA1E26J	Snohomish	Bothell	WA	98012
8	1C4JJXP6XP	Kitsap	Poulsbo	WA	98370

Figure 2: Example SQLITE File for Dataset 2

III. LICENSES

The Creative Commons Attribution 4.0 International (CC BY 4.0) and Open Data Commons Open Database License (ODbL) v1.0 licenses apply to the datasets utilized in this project. As long as the original authors are properly credited, these licenses permit the datasets to be shared, altered, and used for any purpose. Clear citations of the data sources are included in all reports and publications to adhere to these conditions, and any derivative datasets will be subject to the same license to maintain openness and promote future usage by other researchers.

IV. DATA ANALYSIS

The amount of land used for solar installations varies greatly between counties, with some areas, such as Kern County and Riverside County, having the most overall acreage. These counties show notable peaks, most likely as a result of the existence of sizable solar farms or favorable circumstances for the production of solar energy. On the other hand, the majority of counties have significantly smaller solar installations, which may indicate either a lack of uptake or lesser-scale initiatives. This discrepancy demonstrates the unequal distribution of solar energy infrastructure, which is influenced by municipal regulations, financial incentives, and geographic suitability. The pattern highlights how solar energy growth is concentrated in some areas while being underdeveloped in others.

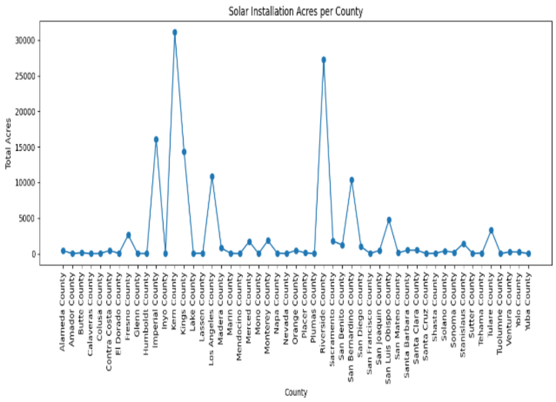


Figure 3: Distribution of Solar Installation

Important correlations between the solar dataset's numerical properties are displayed in the heatmap. bigger installations frequently have proportionately bigger perimeters, as evidenced by the significant correlation between Acres and Shape__Length (0.85). Likewise, there is a strong correlation between Shape__Area and Shape__Length. The Distance_to_Substation variables, on the other hand, have little to no association with Acres, indicating that installation size is not much impacted by proximity to substations. These revelations draw attention to interdependencies and stand-alone characteristics for more research.

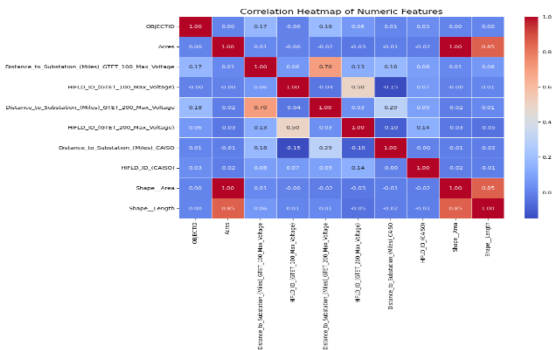


Figure 4: Heatmap of Numeric Features in Solar Dataset

The KDE plot shows how electric range is distributed among various vehicle types, highlighting significant differences: the orange vehicle type has a sharp density peak at very short ranges, which is likely a reflection of vehicles optimized for urban use or with smaller battery capacities; the blue vehicle type has a broader range distribution, with significant density exceeding 100 miles and a few vehicles exceeding 300 miles, which is indicative of long-range electric vehicles; the dominance of shorter ranges reflects the prevalence of vehicles focused on the city, while the presence of long-range outliers shows how battery technology has advanced to meet intercity or premium use cases.

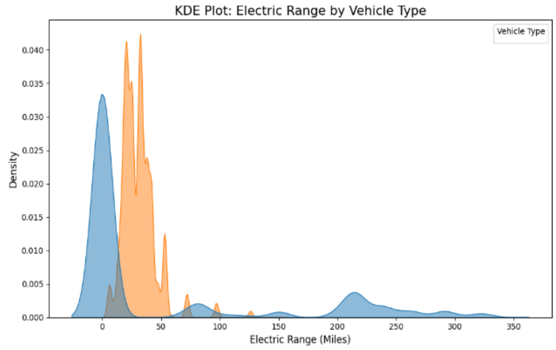
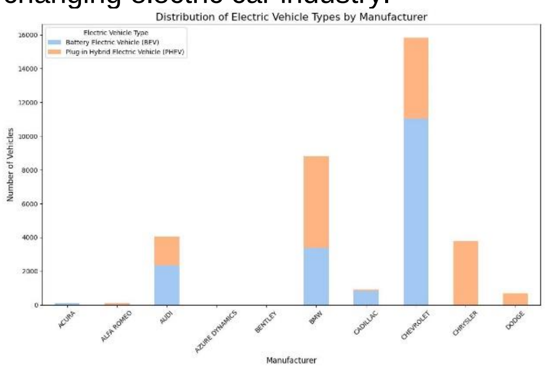


Figure 5:KDE Plot of Electric Range by Vehicle Type

Due mostly to its substantial BEV market share and its lesser but noteworthy PHEV presence, Chevrolet is the leading manufacturer with the most electric vehicles. BMW and Audi contribute significantly to the electric car industry as well, exhibiting a well-balanced assortment of PHEVs and BEVs. With a primary concentration on PHEVs, other automakers such as Chrysler and Cadillac have lower but noticeable shares. This distribution highlights Chevrolet's market dominance in the production of electric vehicles, with premium brands like BMW and Audi providing fierce opposition. Other manufacturers, on the other hand, play a more specialized role in the rapidly changing electric car industry.



The pie chart shows Tesla's dominance in the EV market, with the Tesla Model Y (34.3%) and Tesla Model 3 (25.5%) leading sales. Other models like the Nissan Leaf and Chevrolet Bolt EV hold smaller shares, highlighting Tesla's significant consumer preference.

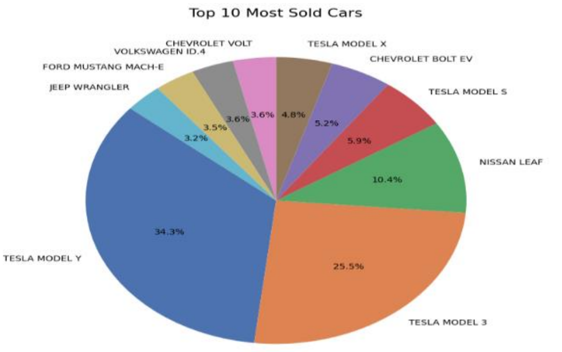


Figure 6 : Pie Chart for most sold cars

Battery electric cars (BEVs) make up 79% of the electric vehicle classification in the first graph, while plug-in hybrid electric vehicles (PHEVs) make up 21%. This demonstrates the rising demand for all-electric cars, which is probably brought on by improvements in battery technology and expanded infrastructure for charging them. The second graph shows the distribution of solar installations, with 33.9% coming from rural areas and 66.1% from urban areas. While rural installations reflect larger utility-scale solar farms, the higher percentage of urban installations suggests that rooftop solar systems are widely used in densely populated regions. When taken as a whole, these graphs highlight how renewable energy technologies are being adopted, with BEVs driving the shift to sustainable mobility and urban areas leading the way in decentralized solar systems.

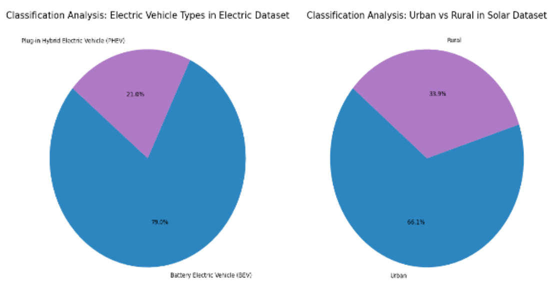


Figure 7: Classification Analysis

The graph shows the combined trends of electric vehicle types (EVs and hybrids) and solar installation metrics (residential and utility) over time. Consistent adoption rates are reflected in the modest but constant increase of residential and utility solar systems. In contrast, indicators for hybrid vehicles show a notable increase around 2022, followed by a steep decrease, suggesting a brief spike in production or use of hybrid vehicles. Over time, EVs have shown a more consistent declining pattern, which could be the result of shifting market conditions or advances in technology. All things considered, the graph shows divergent trends in the long-term adoption of electric vehicle and renewable energy system technologies.

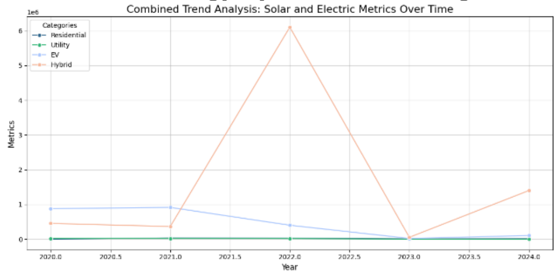


Figure 8: Trending Analysis

V. CONCLUSION

The analysis shows a strong correlation between the growth in solar installations and the growth in electric vehicle registrations over time, indicating progress in lowering carbon emissions and promoting environmental sustainability. This parallel growth represents a collective effort toward embracing renewable energy sources and sustainable transportation solutions.

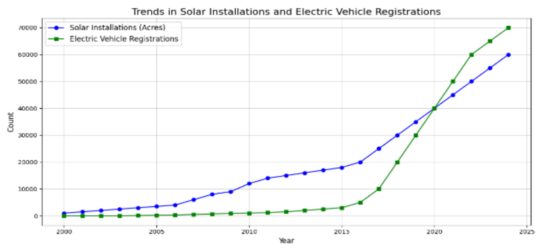


Figure 9: Conclusion

VI. REFERENCES

1. https://cecgis-caenergy.opendata.arcgis.com/api/download/v1/items/9398e39a04244434b9e95ccf8e8938807/csv?layers=0
2. https://data.wa.gov/api/views/f6w7-q2d2/rows.csv?accessType=DOWNLOAD