EV between Adoption and Barriers (Washington State)

Name: Sayed Murtadha Alawi

DAB - 16

Contents

Introduction:

Washington State has more than **39.3 million registered vehicles**, yet only **6%** are electric.
This analysis explores the key factors affecting EV adoption across the state, including population distribution, income levels, political trends, and vehicle-use patterns.
By understanding these factors, we identify challenges, opportunities, and strategies to support a smoother transition from ICE vehicles to cleaner electric options.

Problem Statement:

Washington has over 39.3 million registered vehicles, but only 6% of them are electric.
This large gap highlights uneven EV adoption across the state and slows progress toward reducing emissions and transitioning away from ICE vehicles.

Approaches:

To better understand the factors influencing EV and hybrid adoption, the following analytical approaches were used:

1. Demographic Analysis

- Compare population size across counties (high-population vs. low-population).
- Identify how population correlates with electrification levels.

2. Political Leaning Assessment

- Investigate whether counties with stronger Democratic or Republican votes adopt EVs differently.
- Analyze vote distribution in the 2024 elections to compare with EV penetration.

3. Economic Indicators

- Analyze median income by county.
- Evaluate how higher income regions like King County correlate with EV uptake.

4. Vehicle Registration Analysis

- Compare percentage of ICE, EV, and hybrid vehicles across counties.
- Identify top brands and models for each vehicle type (ICE/EV/Hybrid).
- Understand primary vehicle use and its impact on adoption.

5. Support Program Evaluation

- Consider the effect of federal funds ($38M in 2024) on supporting EV infrastructure and incentives.

Target Audience:

Washington State Department of Transportation (WSDOT) specifically Electrification & Sustainability Team Members

Dataset:

Rows: around 40 M

Columns: 22

Transaction Month and Year	**The month and year in which a transaction was recorded into Department of Licensing's computer system**	**start_of_month**	**Floating Timestamp**
Make	**The manufacturer of the vehicle, determined by decoding the Vehicle Identification Number (VIN)**	**make**	**Text**
Model	**The model of the vehicle, determined by decoding the Vehicle Identification Number (VIN)**	**model**	**Text**
Model Year	**The model year of the vehicle, determined by decoding the Vehicle Identification Number (VIN)**	**model_year**	**Number**
Vehicle Color	**The color of the vehicle. Color is not required and may not be collected when registering or titling a vehicle.**	**primary_color**	**Text**
Vehicle Type	**The category of vehicle based on its physical appearance and/or intended use, as defined by the manufacturer**	**vehicle_type**	**Text**
Vehicle Primary Use	**The way a vehicle was registered to be used through Department of Licensing; similar to 'use class'**	**vehicle_primary_use**	**Text**
Fuel Type Primary	**The source of power that is most often used to power a vehicle**	**fuel_type_primary**	**Text**
Fuel Type Secondary	**An additional source of power that is used to propel the vehicle**	**fuel_type_secondary**	**Text**
Gross Vehicle Weight Rating Class	**A numeric classification (1-8) for the maximum operating weight of a vehicle including its chassis, body, engine, engine fluids, fuel, accessories, driver, passengers and cargo. Typically associated with Trucks.**	**gross_vehicle_weight_rating_class**	**Text**

Gross Vehicle Weight Rating Range (lbs)	The weight range (in pounds) of the maximum operating weight of a vehicle including its chassis, body, engine, engine fluids, fuel, accessories, driver, passengers, and cargo. Typically associated with Trucks.	gross_vehicle_weight_rating_range	Text
Electrification Level	Describes how effectively a vehicle uses electricity to power it. A Mild Hybrid electric vehicle uses an electric battery and electric motor to suppliment the power of an internal combustion engine (ICE) but cannot power the vehicle using electricity alone. The only energy source added externally for this type of vehicle is a petroleum product. A Strong Hybrid electric vehicle also uses an electric battery and electric motor to suppliment the power of an internal combustion engine (ICE). It can power the vehicle using electricity alone. The only energy source added externally for this type of vehicle is a petroleum product. A Plug-in Hybrid electric vehicle (PHEV) uses an electric battery and electric motor as an alternative power source to its internal combustion engine (ICE). It can be powered using electricity alone, and can also be charged by an external source of electricity. An Electric Vehicle (EV) only uses electricity as a source of power.	electrification_level	Text
Plate Background	The background on the issued plate, either standard or a special plate	plate_background	Text
Plate Configuration	The configuration of the plate number. The field displays either a standard or personalized configuration	plate_configuration	Text
Owner Type	Describes if a vehicle is registered by one or more individuals, or a business	owner_type	Text
County	The geographic region of a state that a vehicle's owner is listed to reside within	county	Text
State	This describes the residential or business location of the primary vehicle owner.	state	Text
Postal Code	The 5 digit postal code used by the United States Postal Service (USPS) that a vehicle's owner is listed to reside within	zip_code	Text
Transaction Type	The category of activity that was performed, as defined by Department of Licensing	transaction_type	Text

Transaction Channel	**Describes how the activity was performed. Online: the transaction completed remotely using a Department of Licensing internet-based applications. In-person: the transaction was completed by a person while visiting a Department of Licensing location. By mail: the transaction was remotely requested and paid for via the United States Postal Service (USPS) or a mail courier.**	**transaction_channel**	**Text**
2020 GEOID	**The Geographic Identifier (GEOID) is a combination of the state, county, and census tract codes as assigned by the United States Census Bureau in the 2020 census, also known as Census Tract. More information can be found here: https://www.census.gov/programs-surveys/geography/about/glossary.html#par_textimage_13 https://www.census.gov/programs-surveys/geography/guidance/geo-identifiers.html**	**_2020_census_tract**	**Text**
Transaction Count	**A count of the vehicle registrations based on the fields defined in this dataset**	**vehicle_record_count**	**Number**

Data handling:

Main data

The cleaning was only in tableau where it was big data that Python didn't handle it.

1. Hide 6 rows in Tableau:
    a. vehicle color: a lot of Null, also not needed
    b. Gross Vehicle weight rating class: not needed
    c. Gross Vehicle weight rating range: not needed
    d. Postal Code: we have county and state, over information
    e. 2020 GEOID:
    f. Plate Background: not needed
2. We have null in Fuel Type Secondary, and it is because not all Vehicle have An additional source of power.
3. Change the type of model year to Date

Other data

Cleaning was in Excel

Limitations:

Data Availability

- EV registration data may not capture vehicles registered out-of-state or recently purchased.
- Some counties may have incomplete or outdated income or demographic records.

2. Correlation vs. Causation

- While political leaning, income, and population correlate with EV adoption, they do not directly prove causation.

3. Rapid Market Changes

- EV market conditions (prices, incentives, supply shortages) change quickly and may not be reflected in the analysis.

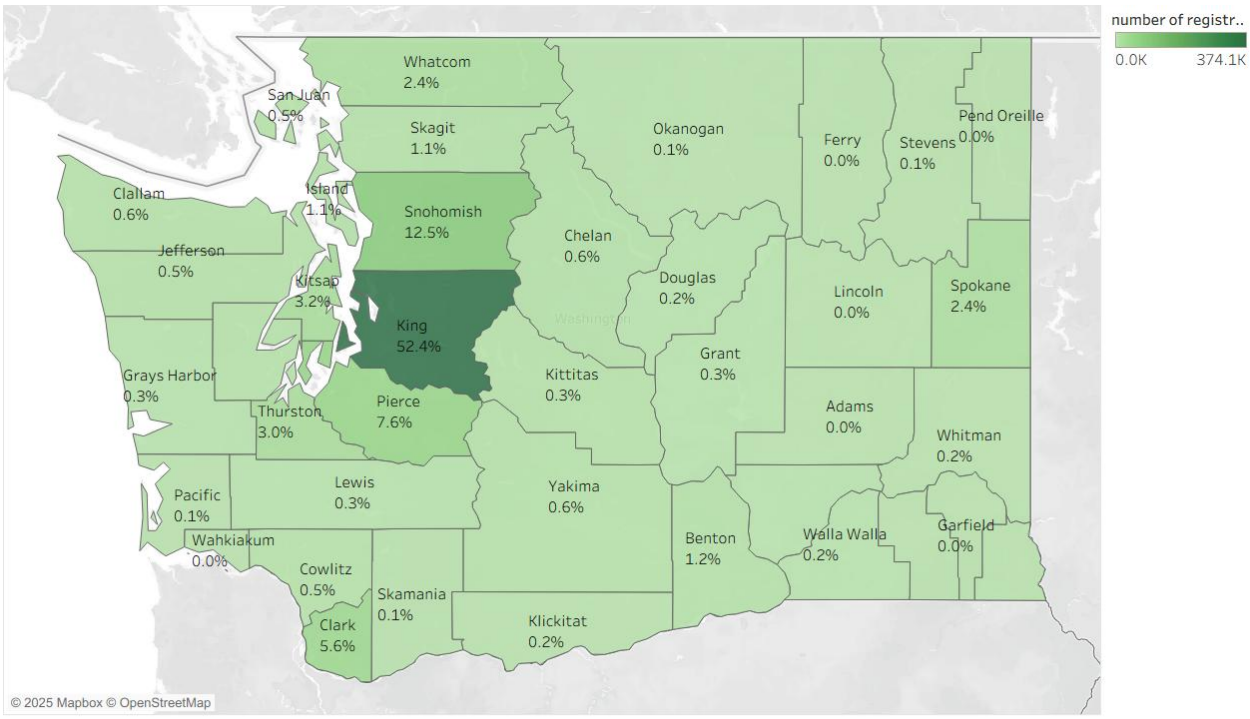
4. Infrastructure Variability

- Charging infrastructure data may vary between public vs. private installations and may not reflect total access.

5. Behavioral Factors Not Captured

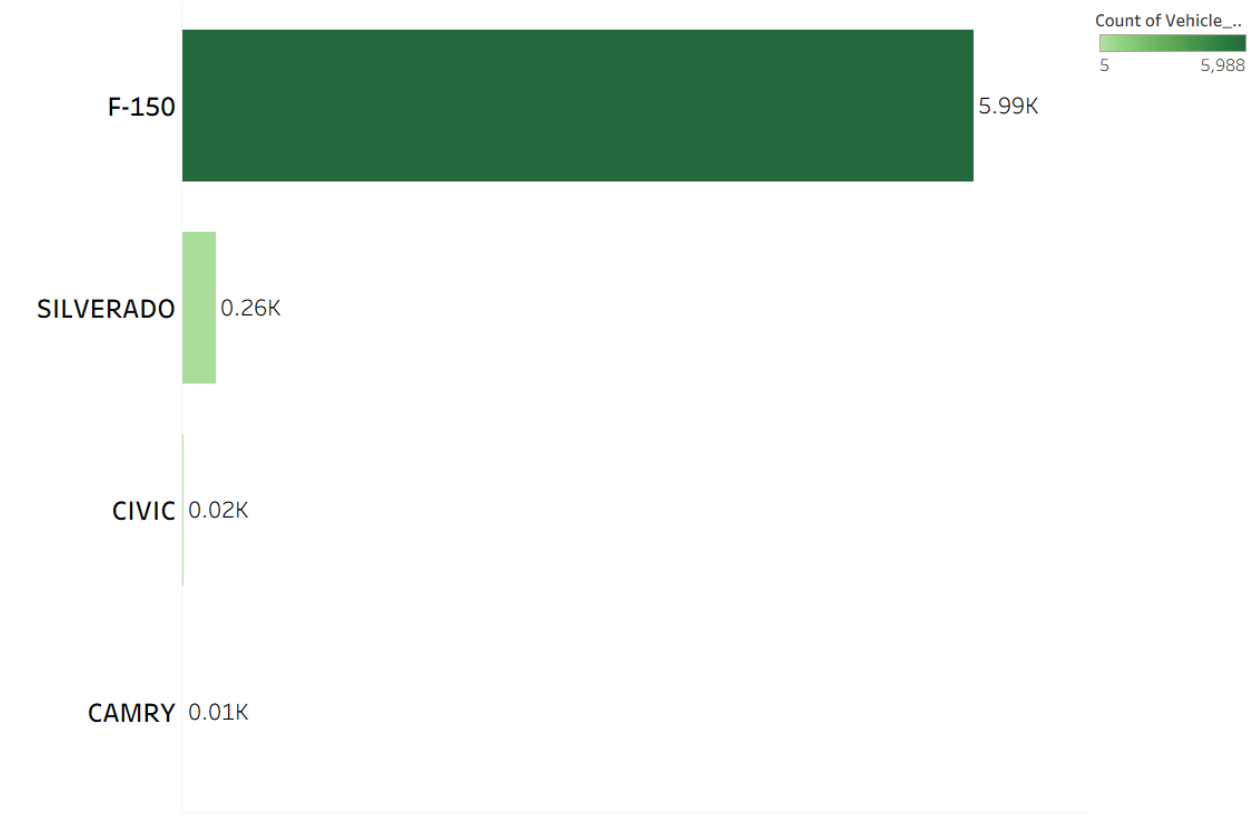
- Individual preferences, brand loyalty, and personal driving habits are not directly reflected in the dataset.

Analysis:

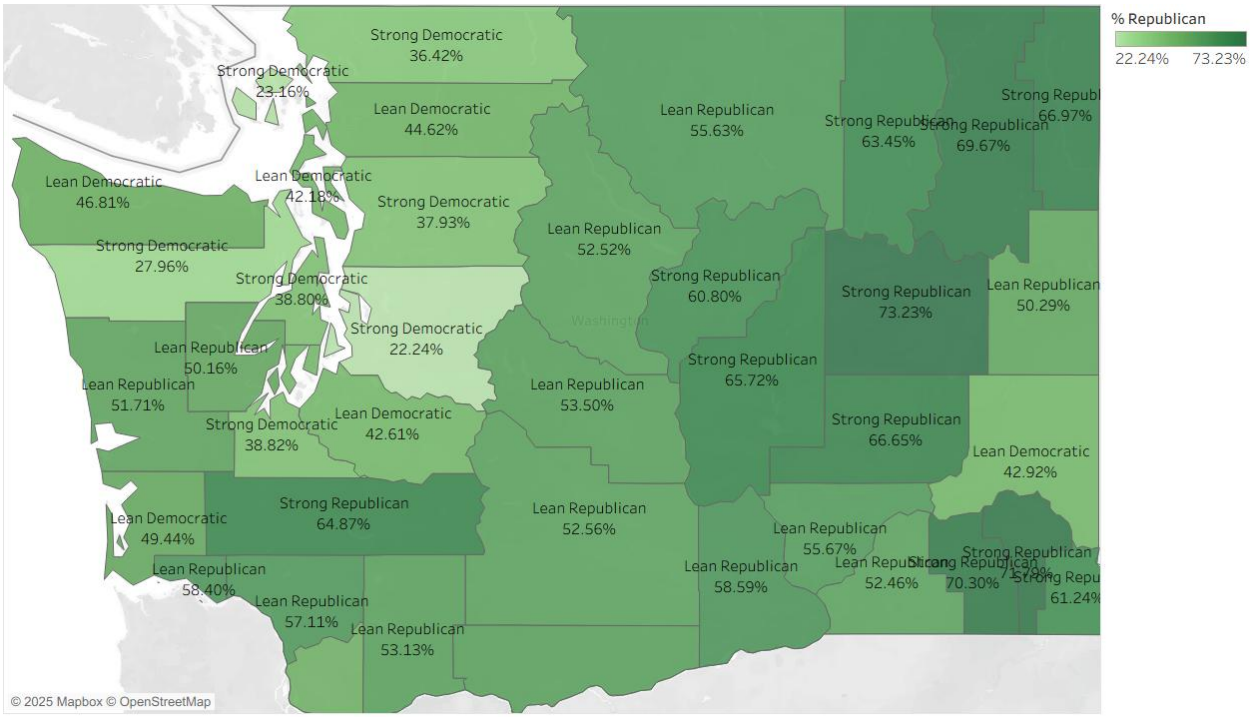


Map based on Longitude (generated) and Latitude (generated). Color shows count of Vehicle_Registration_Transactions_by_Department_of_Licensing_20251122.csv. The marks are labeled by % of Total Count of Vehicle_Registration_Transactions_by_Department_of_Licensing_20251122.csv and County. Details are shown for County. The data is filtered on Electrification Level (group), which keeps BEV (Battery Electric Vehicle). The view is filtered on Latitude (generated) and Longitude (generated). The Latitude (generated) filter keeps non-Null values only. The Longitude (generated) filter keeps non-Null values only.

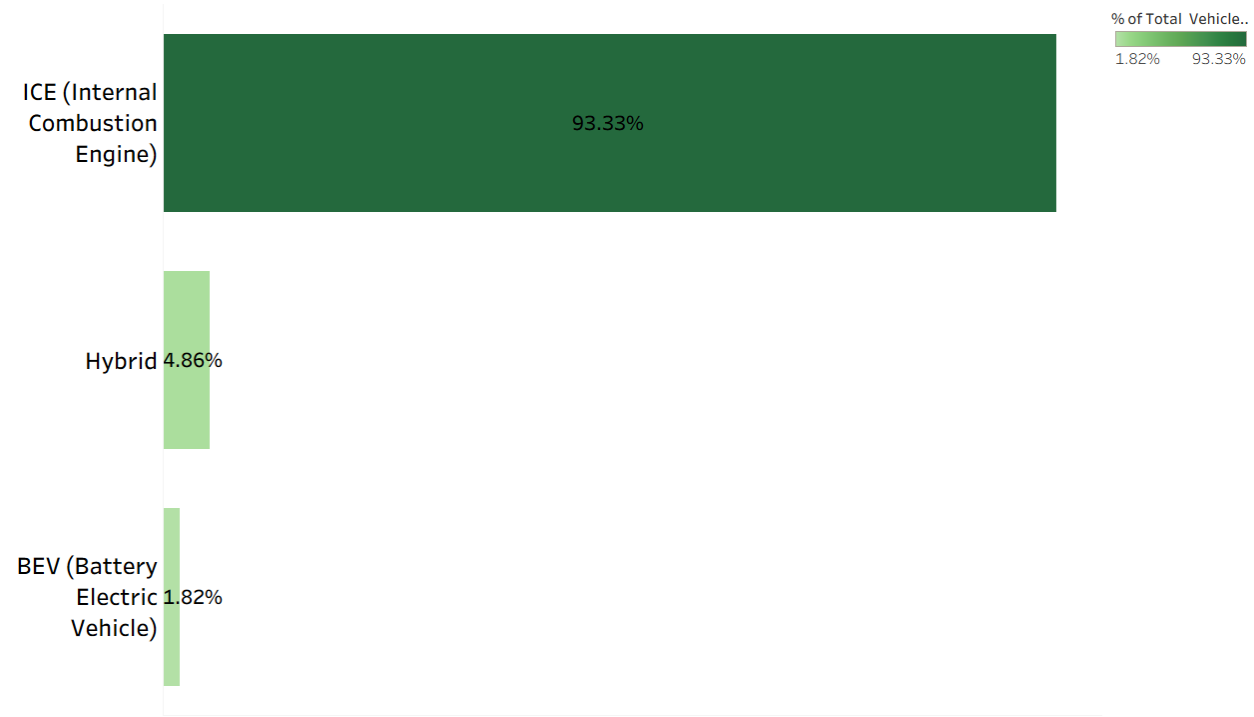
Count of Vehicle_Registration_Transactions_by_Department_of_Licensing_20251122.csv for each Make. Color shows count of Vehicle_Registration_Transactions_by_Department_of_Licensing_20251122.csv. The marks are labeled by count of Vehicle_Registration_Transactions_by_Department_of_Licensing_20251122.csv. The data is filtered on Electrification Level (group), which keeps BEV (Battery Electric Vehicle). The view is filtered on Make, which keeps CHEVROLET, FORD, HONDA and TOYOTA.



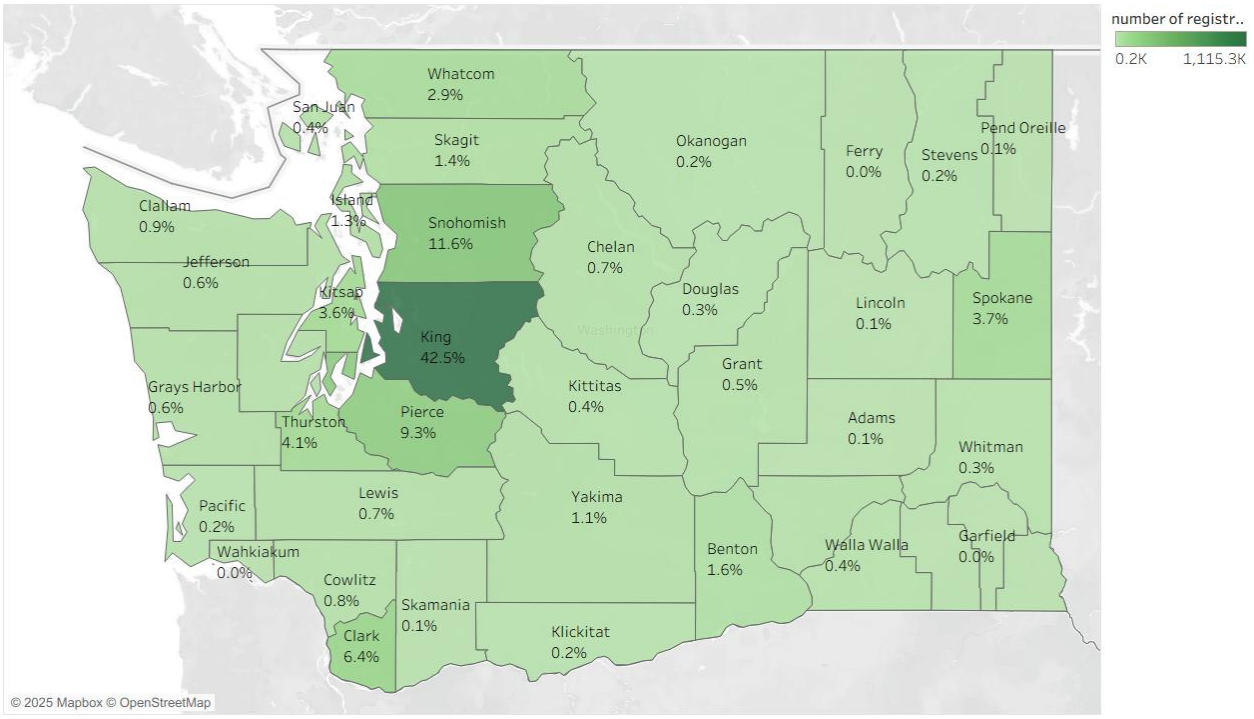
Count of Vehicle_Registration_Transactions_by_Department_of_Licensing_20251122.csv for each Model. Color shows count of Vehicle_Registration_Transactions_by_Department_of_Licensing_20251122.csv. The marks are labeled by count of Vehicle_Registration_Transactions_by_Department_of_Licensing_20251122.csv. The data is filtered on Electrification Level (group), which keeps BEV (Battery Electric Vehicle). The view is filtered on Model, which keeps CAMRY, CIVIC, F-150 and SILVERADO.



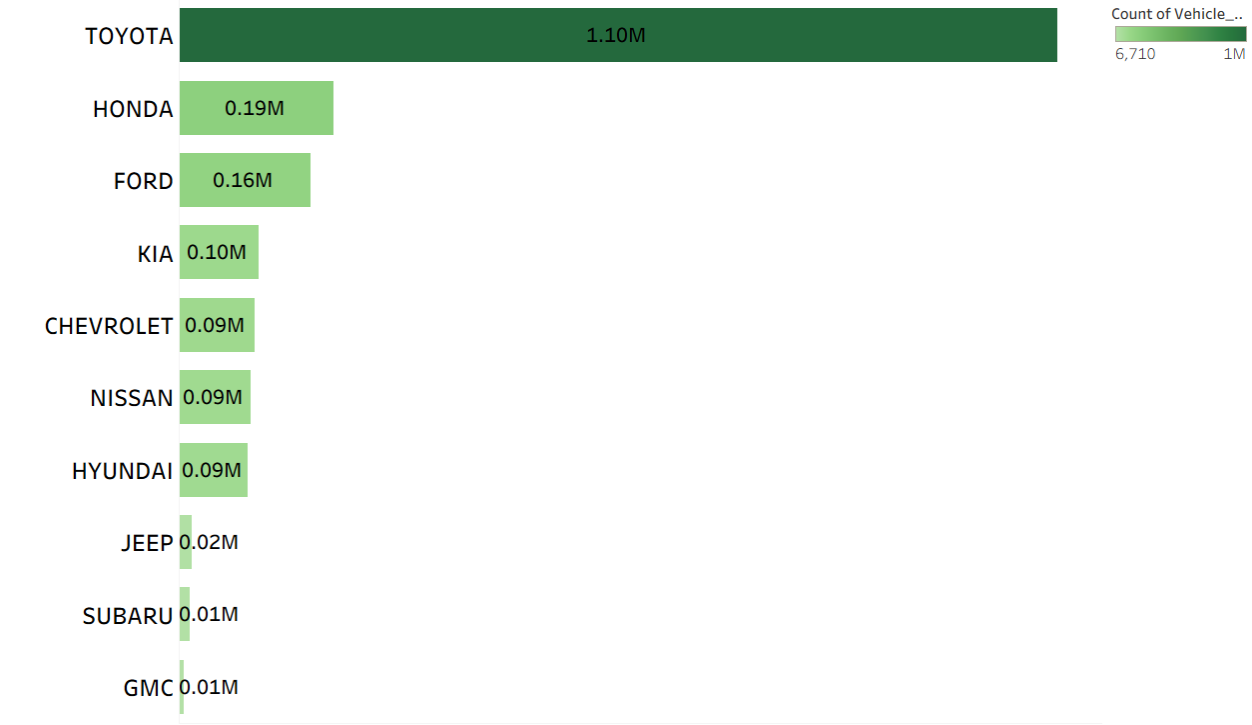
Map based on Longitude (generated) and Latitude (generated). Color shows sum of Per Gop. The marks are labeled by Political_Leaning and sum of Per Gop. Details are shown for County Name. The data is filtered on State Name, which keeps Washington.



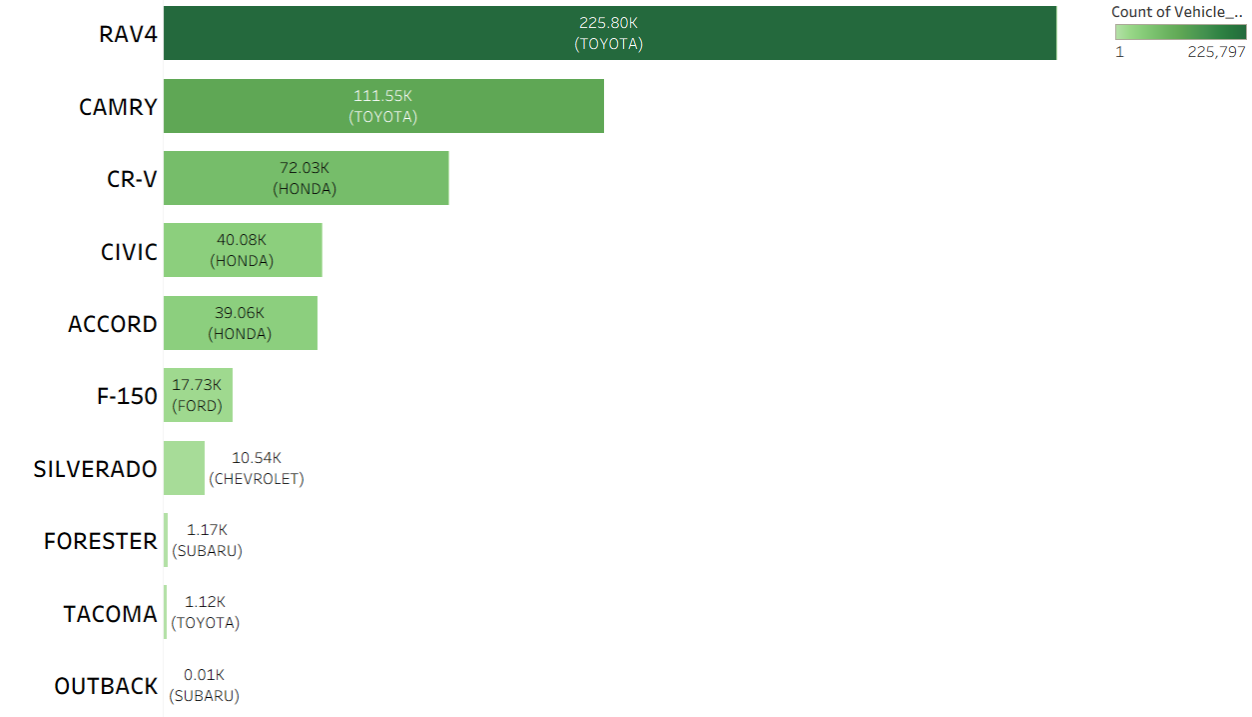
% of Total Count of Vehicle_Registration_Transactions_by_Department_of_Licensing_20251122.csv for each Electrification Level (group). Color shows % of Total Count of Vehicle_Registration_Transactions_by_Department_of_Licensing_20251122.csv. The marks are labeled by % of Total Count of Vehicle_Registration_Transactions_by_Department_of_Licensing_20251122.csv. The view is filtered on Electrification Level (group), which excludes Not Applicable. Percents are based on the whole table.



Map based on Longitude (generated) and Latitude (generated). Color shows count of Vehicle_Registration_Transactions_by_Department_of_Licensing_20251122.csv. The marks are labeled by % of Total Count of Vehicle_Registration_Transactions_by_Department_of_Licensing_20251122.csv and County. Details are shown for County. The data is filtered on Electrification Level, which keeps BEV (Battery Electric Vehicle), HEV (Hybrid Electric Vehicle) - Level Unknown, Mild HEV (Hybrid Electric Vehicle), PHEV (Plug-in Hybrid Electric Vehicle) and Strong HEV (Hybrid Electric Vehicle). The view is filtered on Latitude (generated) and Longitude (generated). The Latitude (generated) filter keeps non-Null values only. The Longitude (generated) filter keeps non-Null values only.

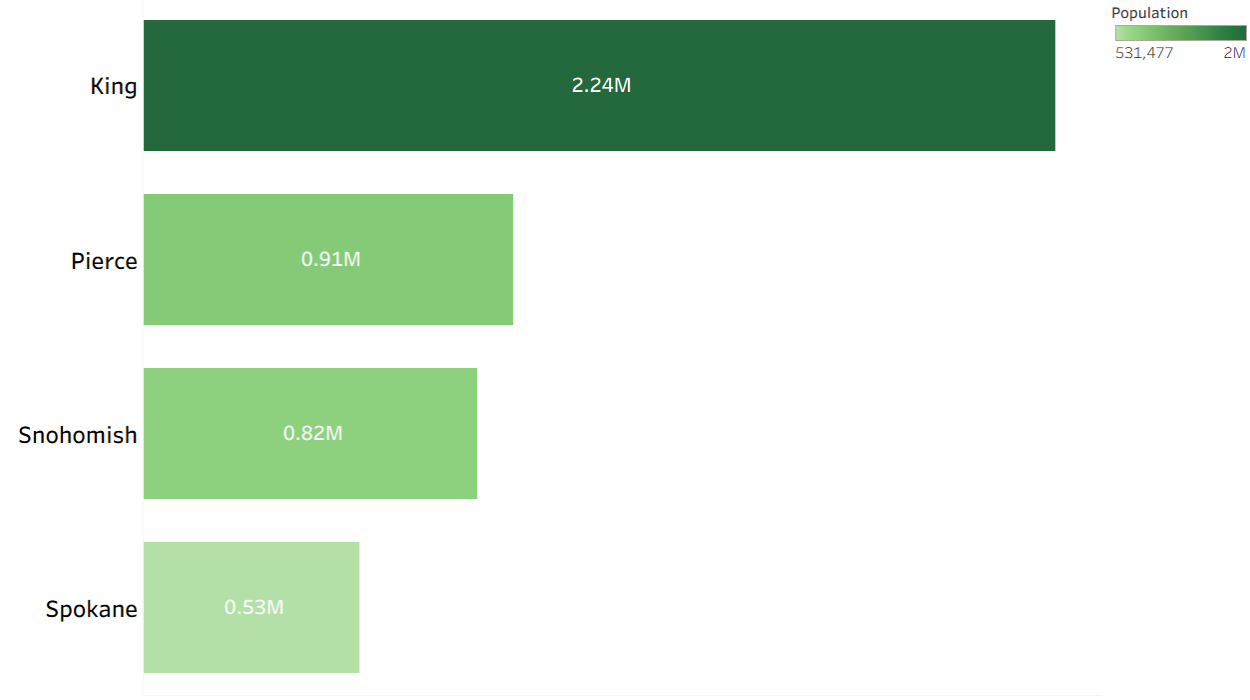


Count of Vehicle_Registration_Transactions_by_Department_of_Licensing_20251122.csv for each Make. Color shows count of Vehicle_Registration_Transactions_by_Department_of_Licensing_20251122.csv. The marks are labeled by count of Vehicle_Registration_Transactions_by_Department_of_Licensing_20251122.csv. The data is filtered on Electrification Level, which excludes ICE (Internal Combustion Engine) and Not Applicable. The view is filtered on Make, which keeps 10 of 1,937 members.

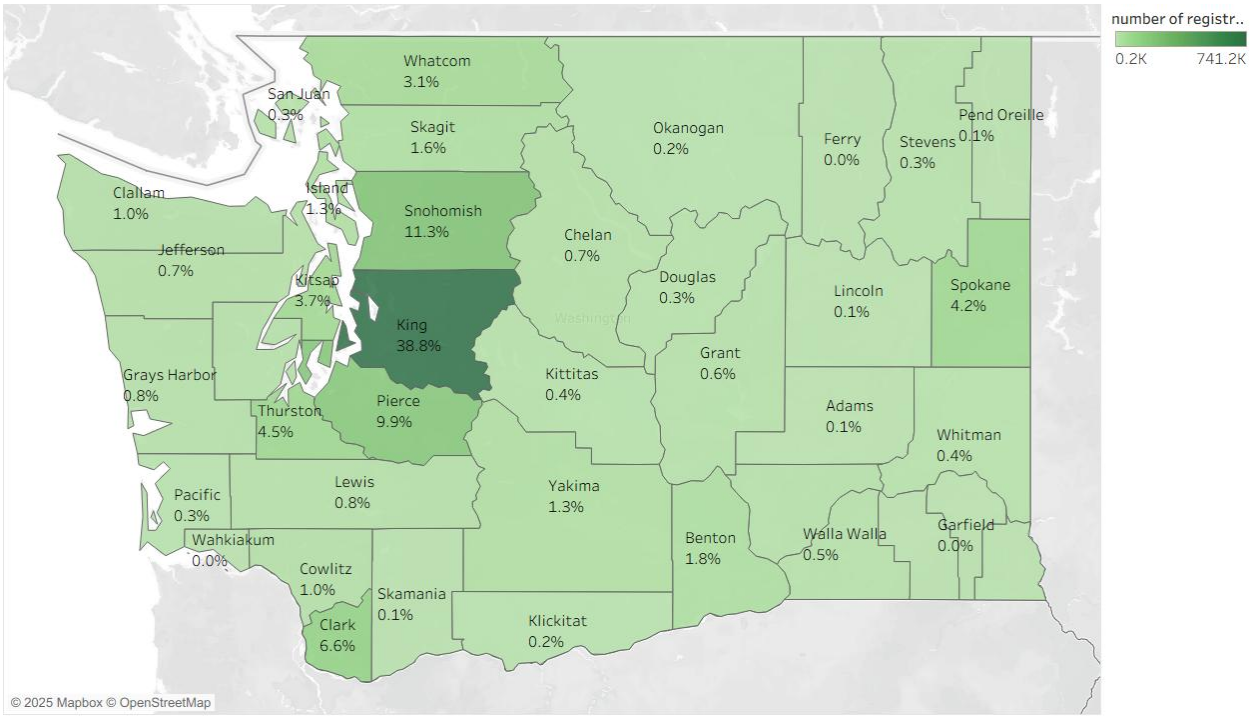


Count of Vehicle_Registration_Transactions_by_Department_of_Licensing_20251122.csv for each Model. Color shows count of Vehicle_Registration_Transactions_by_Department_of_Licensing_20251122.csv. The marks are labeled by count of Vehicle_Registration_Transactions_by_Department_of_Licensing_20251122.csv and Make. The data is filtered on Electrification Level, which excludes ICE (Internal Combustion Engine) and Not Applicable. The view is filtered on Model and Exclusions (Make,Model). The Model filter keeps 10 of 20,312 members. The Exclusions (Make,Model) filter keeps 27,349 members.

Sum of Value (Dollars) for each County (HDPulse data export.csv). Color shows sum of Value (Dollars). The marks are labeled by sum of Value (Dollars). The data is filtered on income category, which keeps Very High Income.

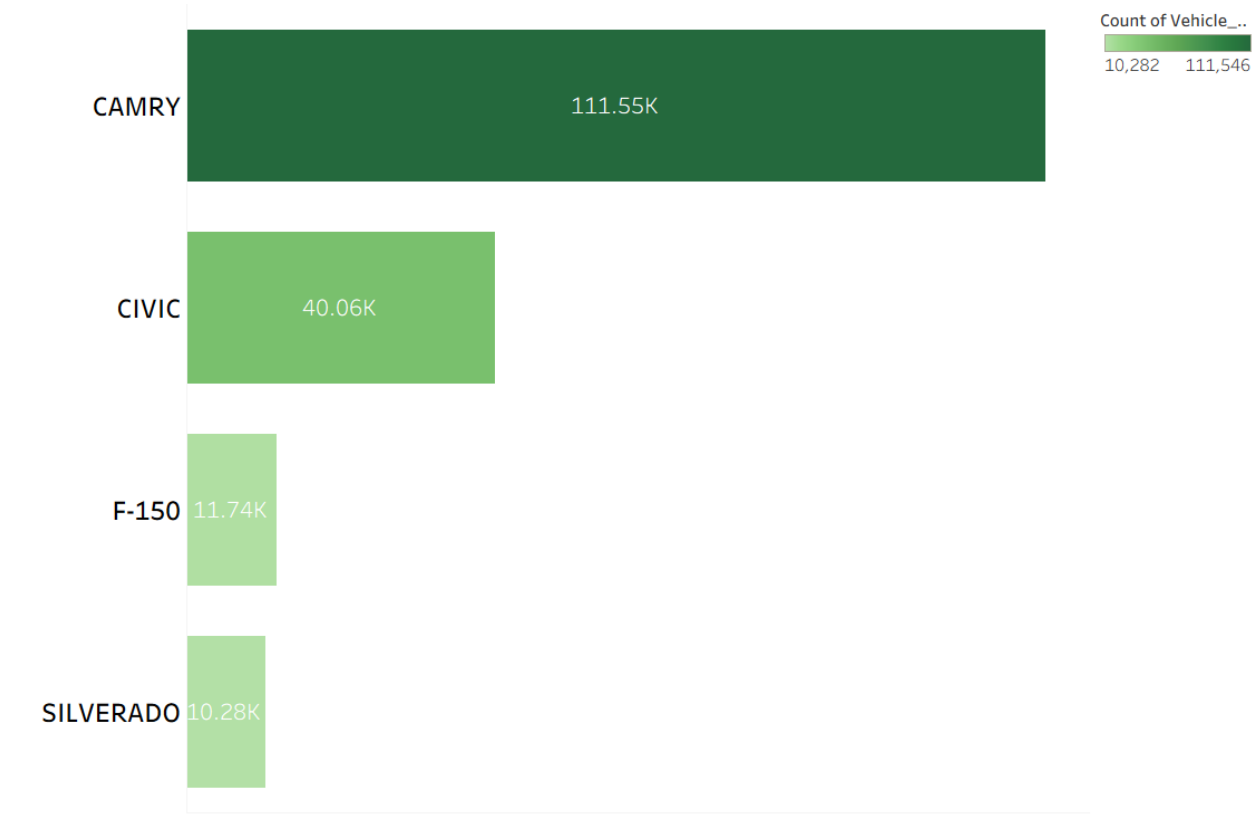


Sum of Population for each County (Sheet1). Color shows sum of Population. The marks are labeled by sum of Population. The data is filtered on Population Category, which keeps Very Large. The view is filtered on County (Sheet1), which keeps 39 of 39 members.

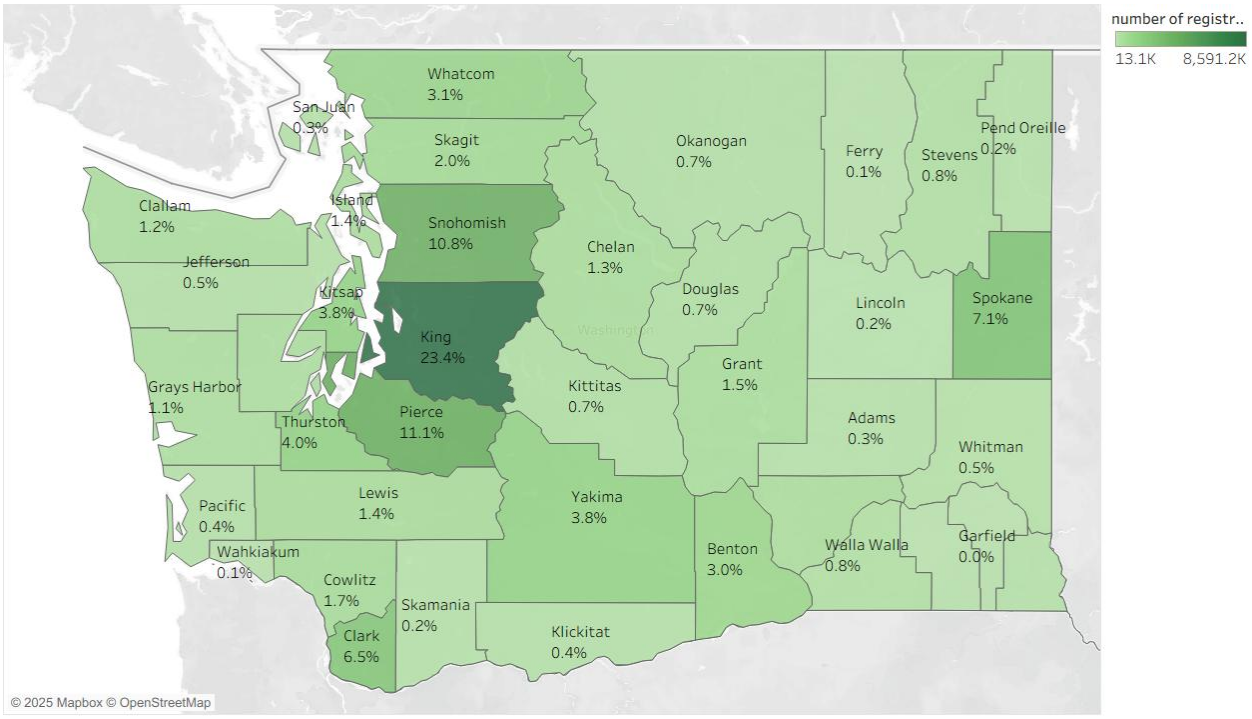


Map based on Longitude (generated) and Latitude (generated). Color shows count of Vehicle_Registration_Transactions_by_Department_of_Licensing_20251122.csv. The marks are labeled by % of Total Count of Vehicle_Registration_Transactions_by_Department_of_Licensing_20251122.csv and County. Details are shown for County. The data is filtered on Electrification Level (group), which keeps Hybrid. The view is filtered on Latitude (generated) and Longitude (generated). The Latitude (generated) filter keeps non-Null values only. The Longitude (generated) filter keeps non-Null values only.

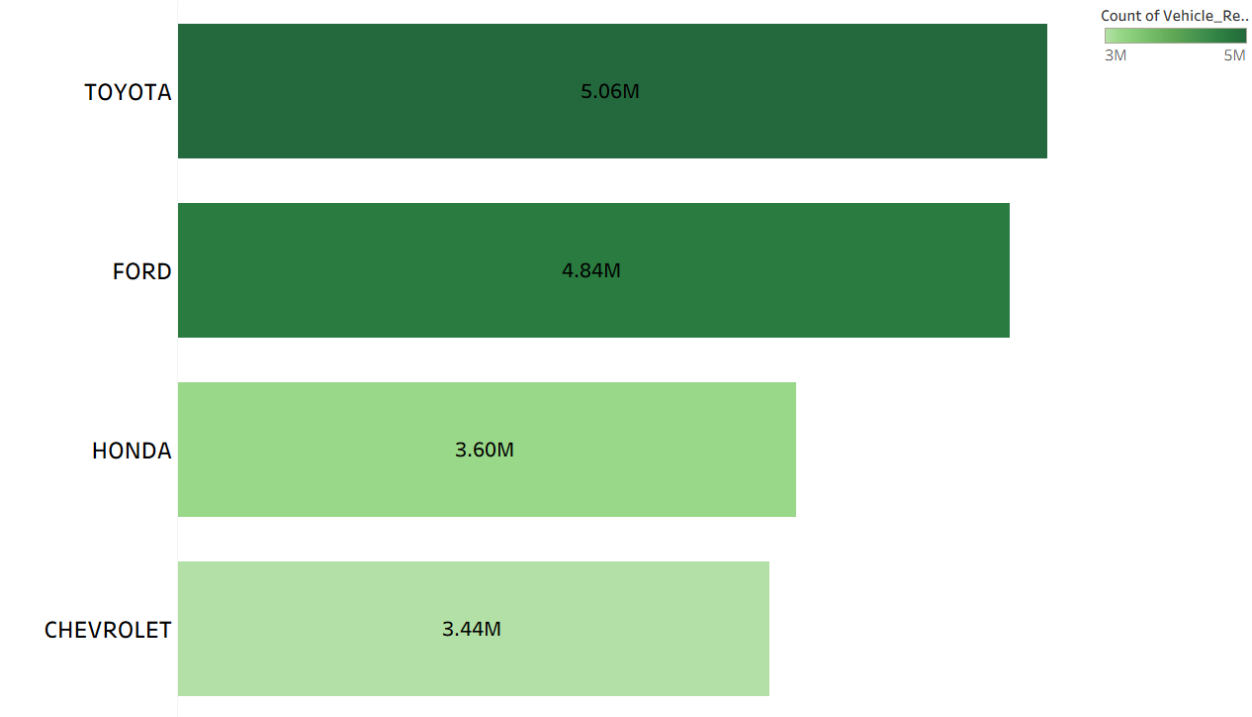
Count of Vehicle_Registration_Transactions_by_Department_of_Licensing_20251122.csv for each Make. Color shows count of Vehicle_Registration_Transactions_by_Department_of_Licensing_20251122.csv. The marks are labeled by count of Vehicle_Registration_Transactions_by_Department_of_Licensing_20251122.csv. The data is filtered on Electrification Level (group), which keeps Hybrid. The view is filtered on Make, which keeps CHEVROLET, FORD, HONDA and TOYOTA.



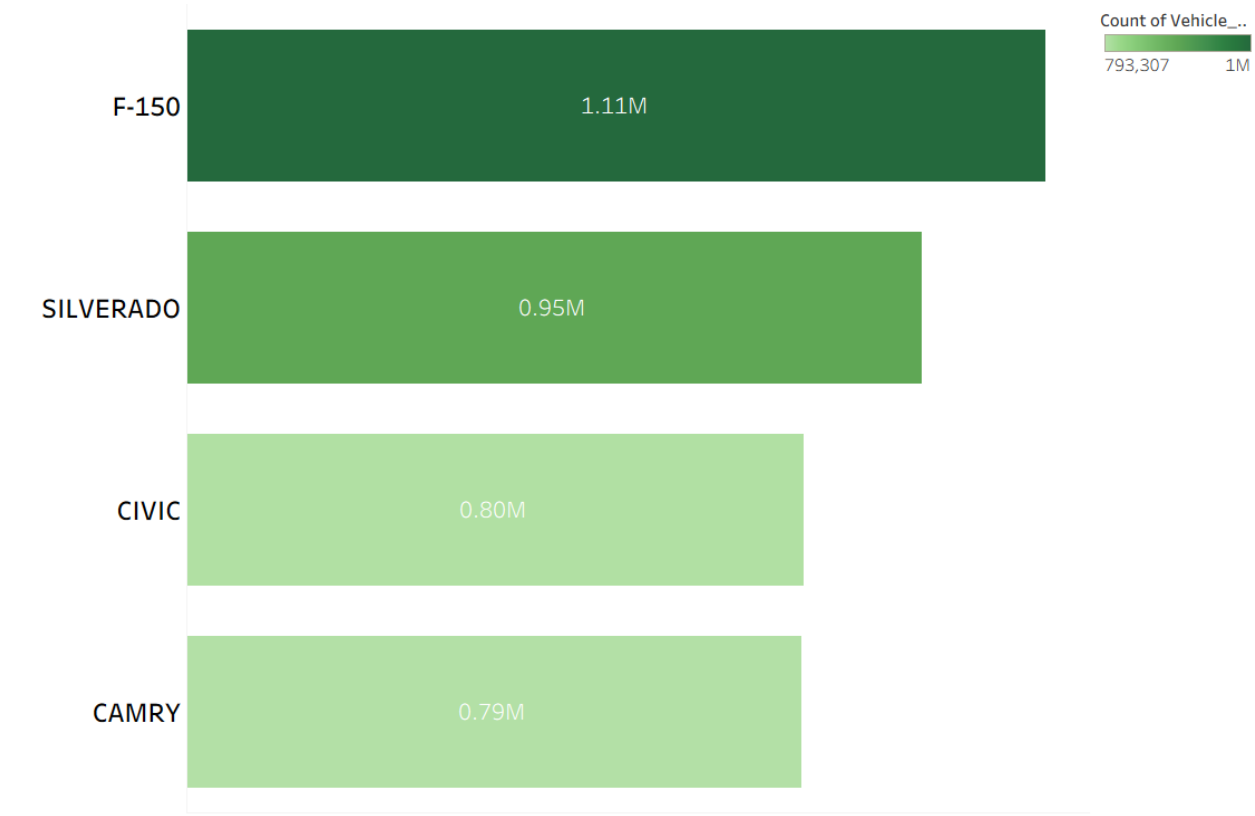
Count of Vehicle_Registration_Transactions_by_Department_of_Licensing_20251122.csv for each Model. Color shows count of Vehicle_Registration_Transactions_by_Department_of_Licensing_20251122.csv. The marks are labeled by count of Vehicle_Registration_Transactions_by_Department_of_Licensing_20251122.csv. The data is filtered on Electrification Level (group), which keeps Hybrid. The view is filtered on Model, which keeps CAMRY, CIVIC, F-150 and SILVERADO.



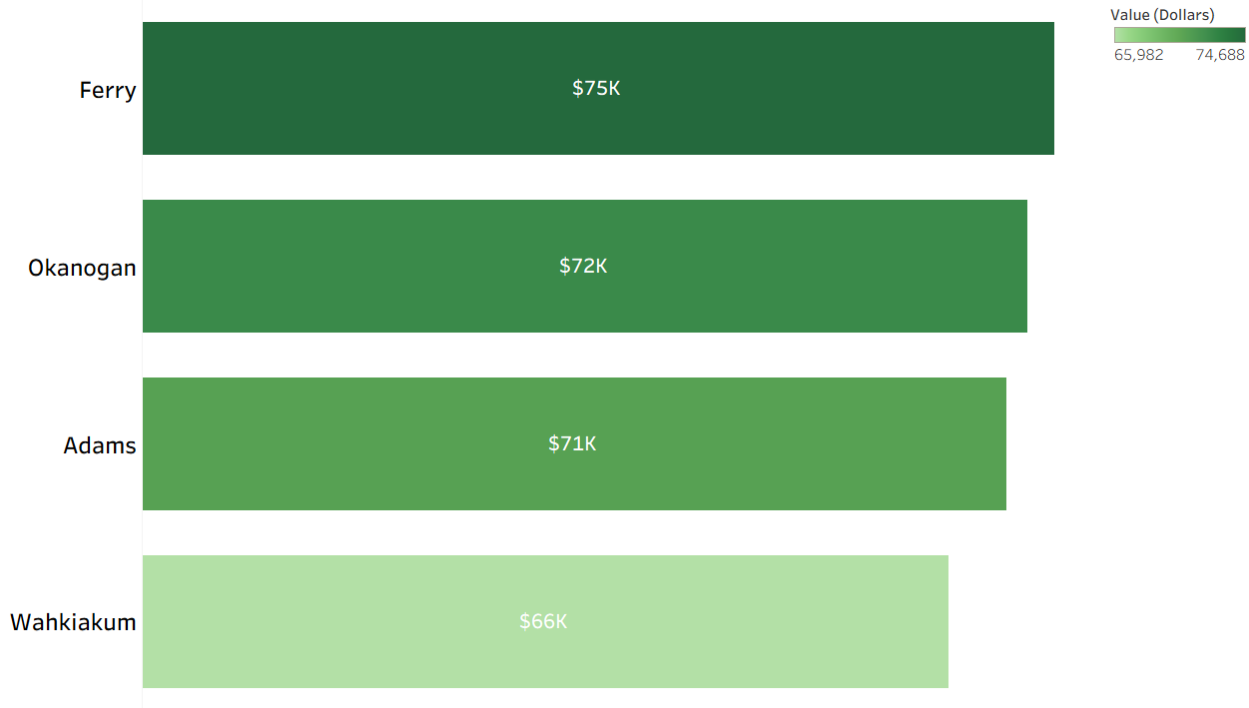
Map based on Longitude (generated) and Latitude (generated). Color shows count of Vehicle_Registration_Transactions_by_Department_of_Licensing_20251122.csv. The marks are labeled by % of Total Count of Vehicle_Registration_Transactions_by_Department_of_Licensing_20251122.csv and County. Details are shown for County. The data is filtered on Electrification Level, which keeps ICE (Internal Combustion Engine). The view is filtered on Latitude (generated) and Longitude (generated). The Latitude (generated) filter keeps non-Null values only. The Longitude (generated) filter keeps non-Null values only.



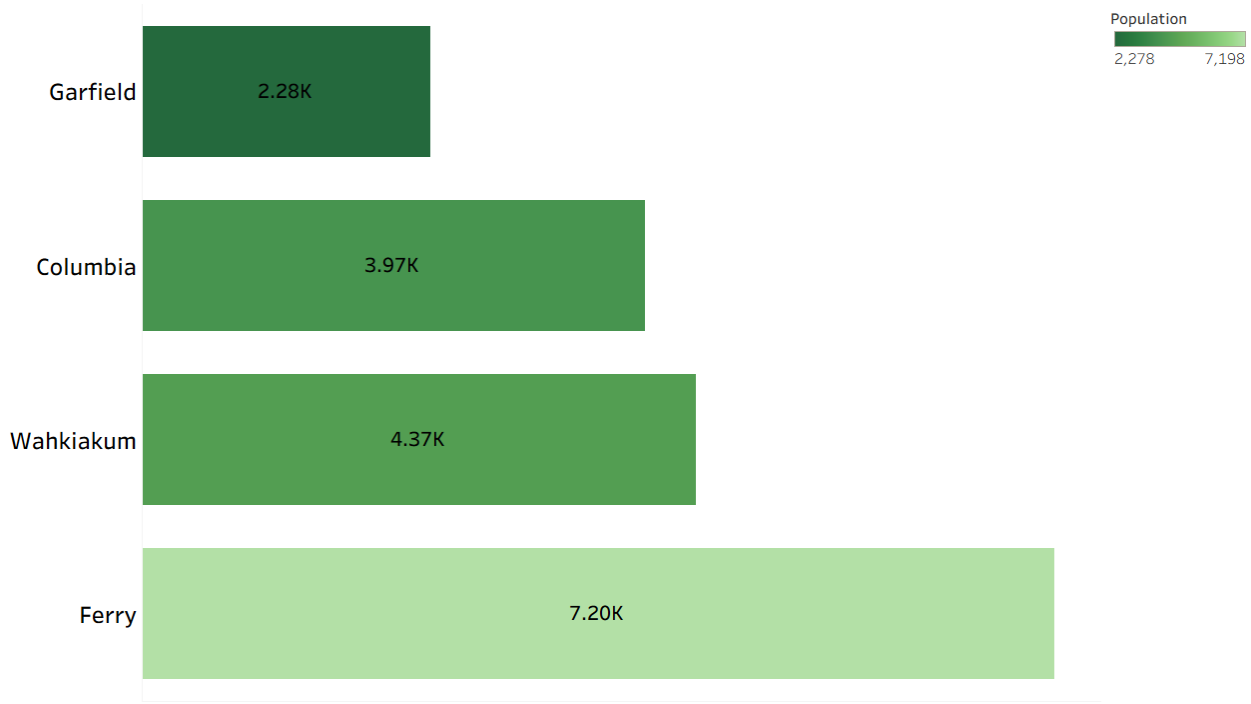
Count of Vehicle_Registration_Transactions_by_Department_of_Licensing_20251122.csv for each Make. Color shows count of Vehicle_Registration_Transactions_by_Department_of_Licensing_20251122.csv. The marks are labeled by count of Vehicle_Registration_Transactions_by_Department_of_Licensing_20251122.csv. The data is filtered on Electrification Level (group), which keeps ICE (Internal Combustion Engine). The view is filtered on Make, which keeps CHEVROLET, FORD, HONDA and TOYOTA.



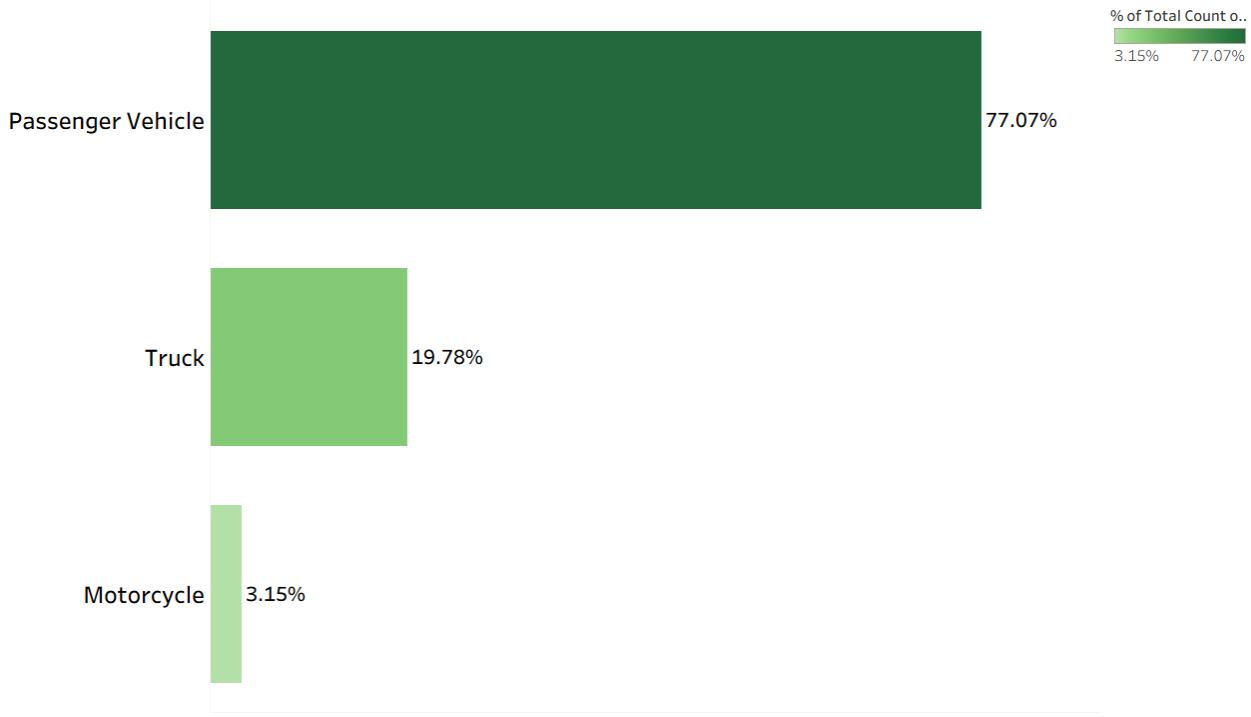
Count of Vehicle_Registration_Transactions_by_Department_of_Licensing_20251122.csv for each Model. Color shows count of Vehicle_Registration_Transactions_by_Department_of_Licensing_20251122.csv. The marks are labeled by count of Vehicle_Registration_Transactions_by_Department_of_Licensing_20251122.csv. The data is filtered on Electrification Level (group), which keeps ICE (Internal Combustion Engine). The view is filtered on Model, which keeps CAMRY, CIVIC, F-150 and SILVERADO.



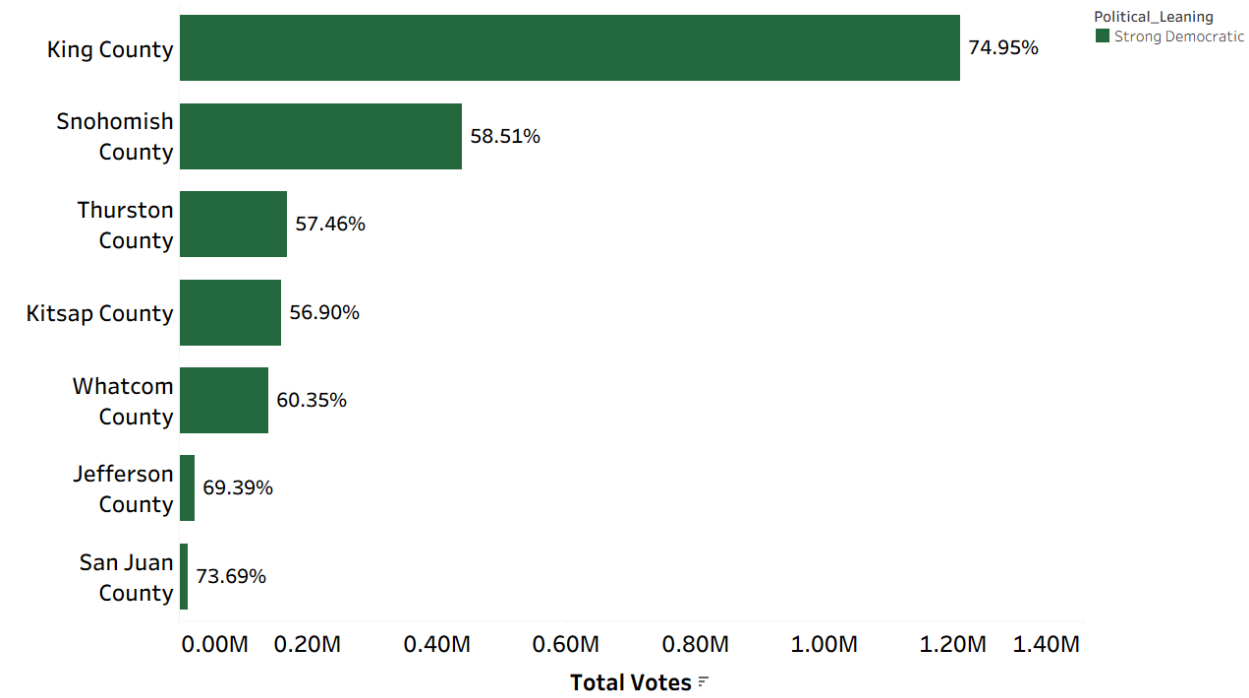
Sum of Value (Dollars) for each County (HDPulse data export.csv). Color shows sum of Value (Dollars). The marks are labeled by sum of Value (Dollars). The data is filtered on income category, which keeps Low Income.



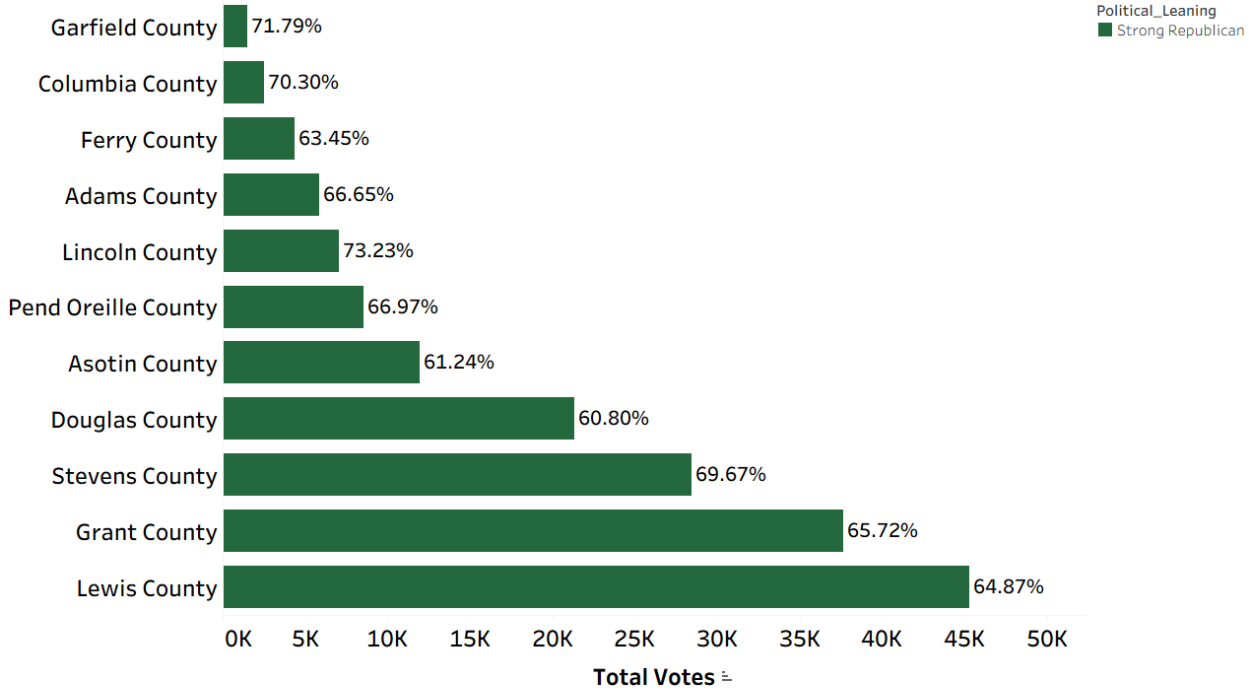
Sum of Population for each County (Sheet1). Color shows sum of Population. The marks are labeled by sum of Population. The data is filtered on Population Category, which keeps Small. The view is filtered on County (Sheet1), which keeps Columbia, Ferry, Garfield and Wahkiakum.



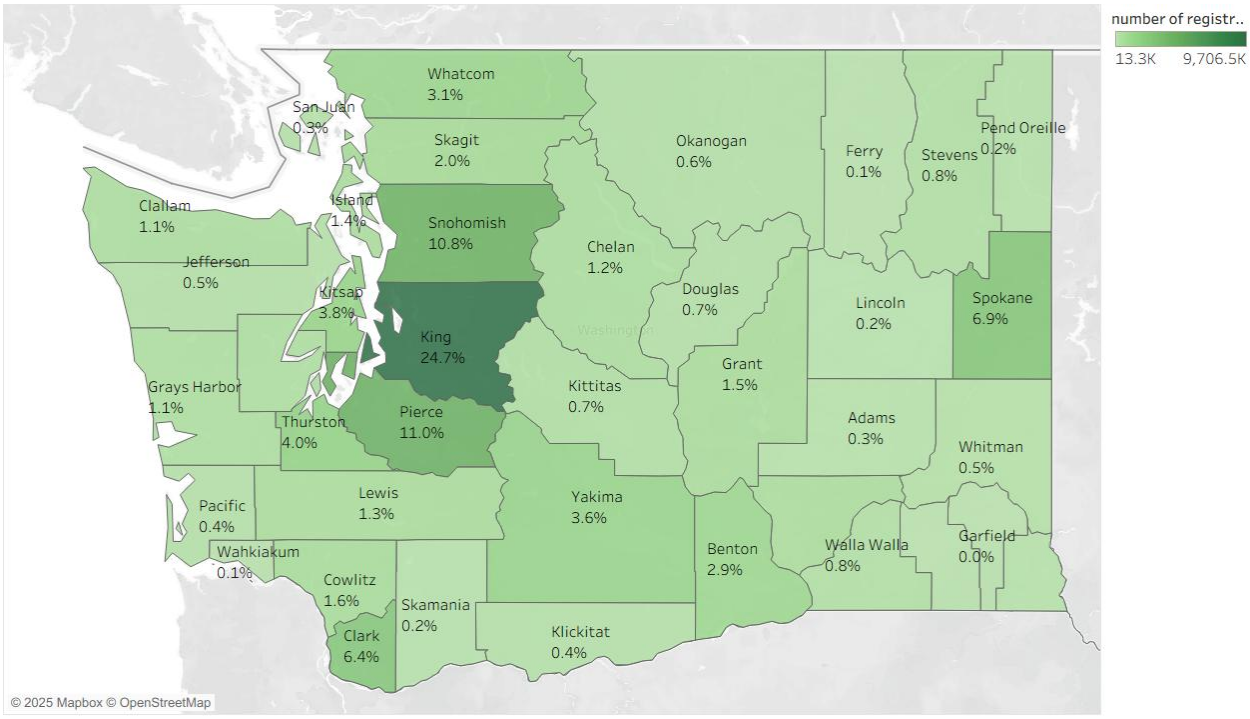
% of Total Count of Vehicle_Registration_Transactions_by_Department_of_Licensing_20251122.csv for each Vehicle Primary Use. Color shows % of Total Count of Vehicle_Registration_Transactions_by_Department_of_Licensing_20251122.csv. The marks are labeled by % of Total Count of Vehicle_Registration_Transactions_by_Department_of_Licensing_20251122.csv. Percents are based on the whole table.



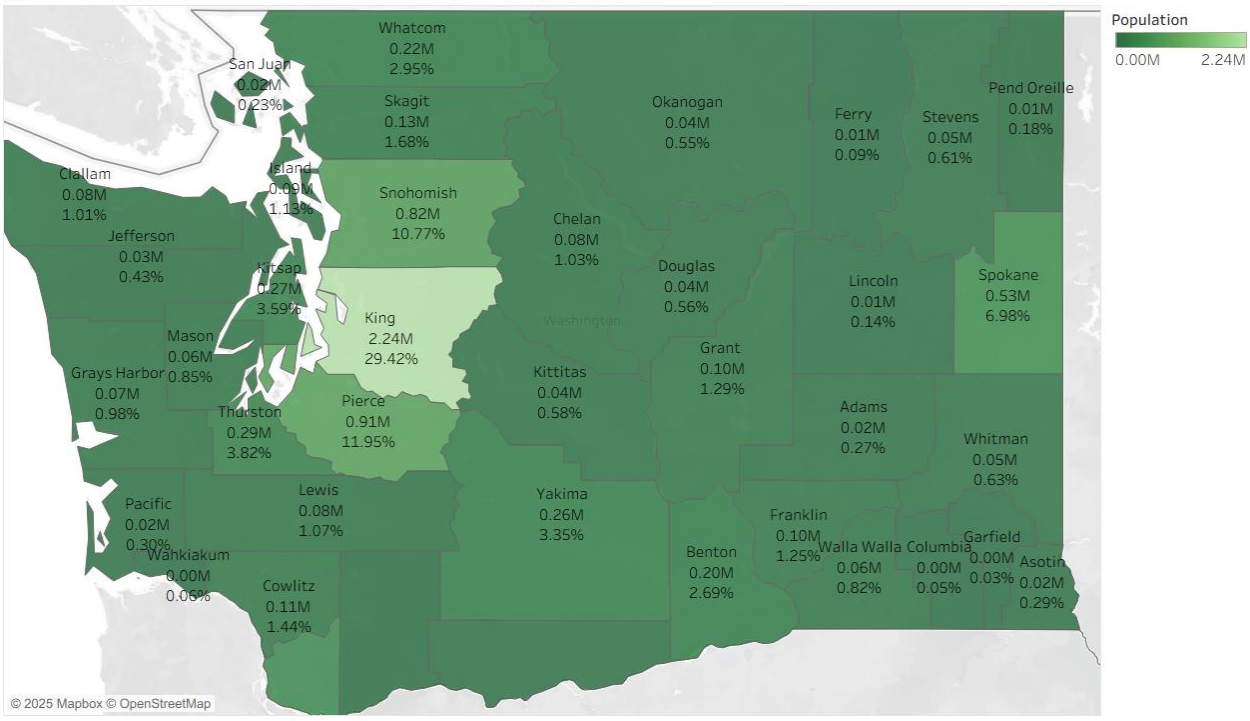
Sum of Total Votes for each County Name. Color shows details about Political_Leaning. The marks are labeled by sum of Per Dem. The data is filtered on State Name, which keeps Washington. The view is filtered on County Name and Political_Leaning. The County Name filter keeps 1,887 of 1,887 members. The Political_Leaning filter keeps Strong Democratic.



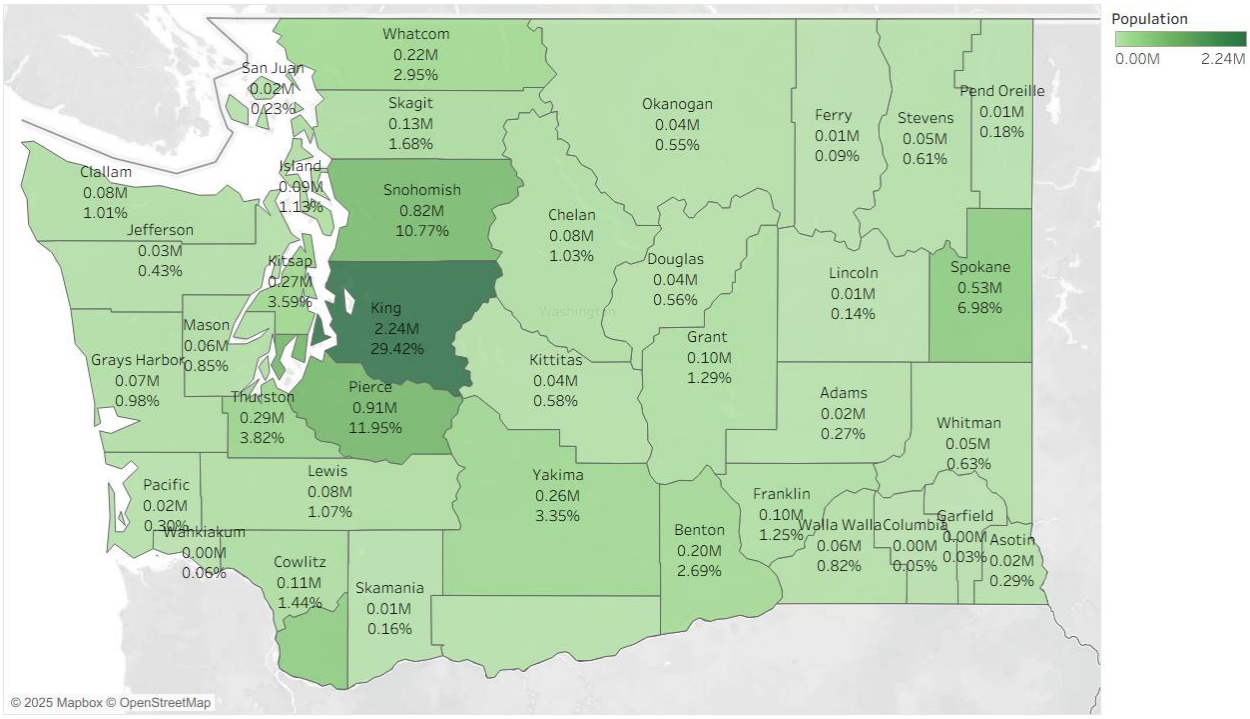
Sum of Total Votes for each County Name. Color shows details about Political_Leaning. The marks are labeled by sum of Per Gop. The data is filtered on State Name, which keeps Washington. The view is filtered on Political_Leaning, which keeps Strong Republican.



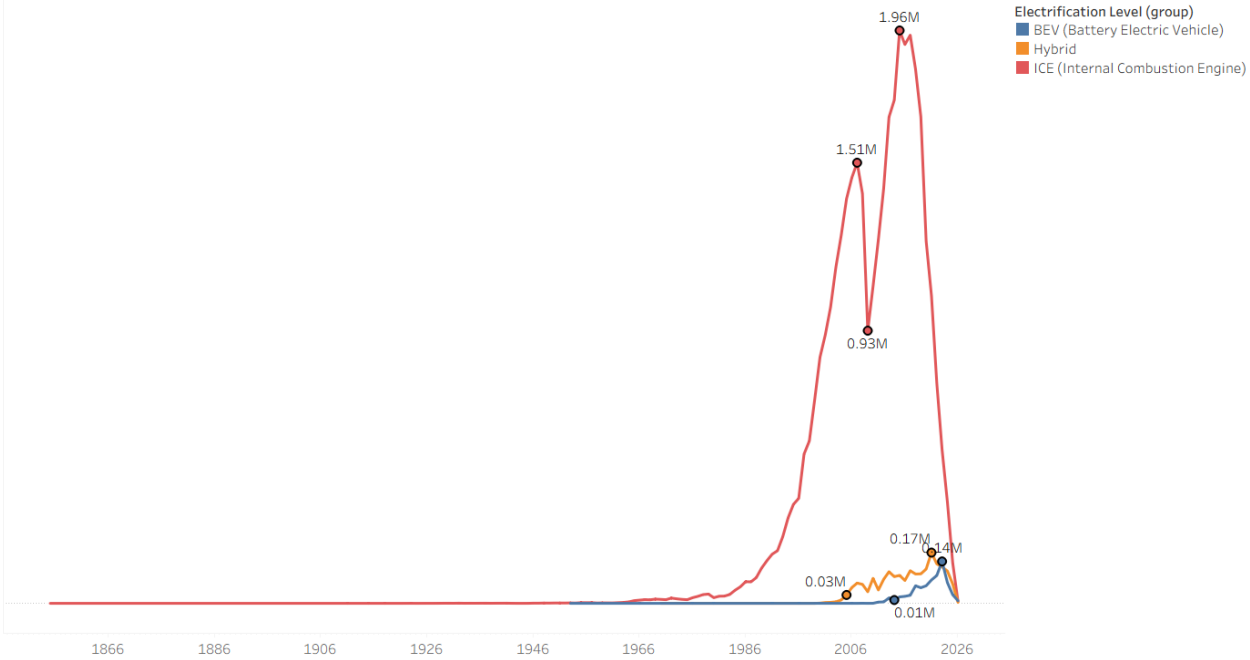
Map based on Longitude (generated) and Latitude (generated). Color shows count of Vehicle_Registration_Transactions_by_Department_of_Licensing_20251122.csv. The marks are labeled by % of Total Count of Vehicle_Registration_Transactions_by_Department_of_Licensing_20251122.csv and County. Details are shown for County. The data is filtered on Electrification Level, which keeps 8 of 8 members. The view is filtered on Latitude (generated) and Longitude (generated). The Latitude (generated) filter keeps non-Null values only. The Longitude (generated) filter keeps non-Null values only.



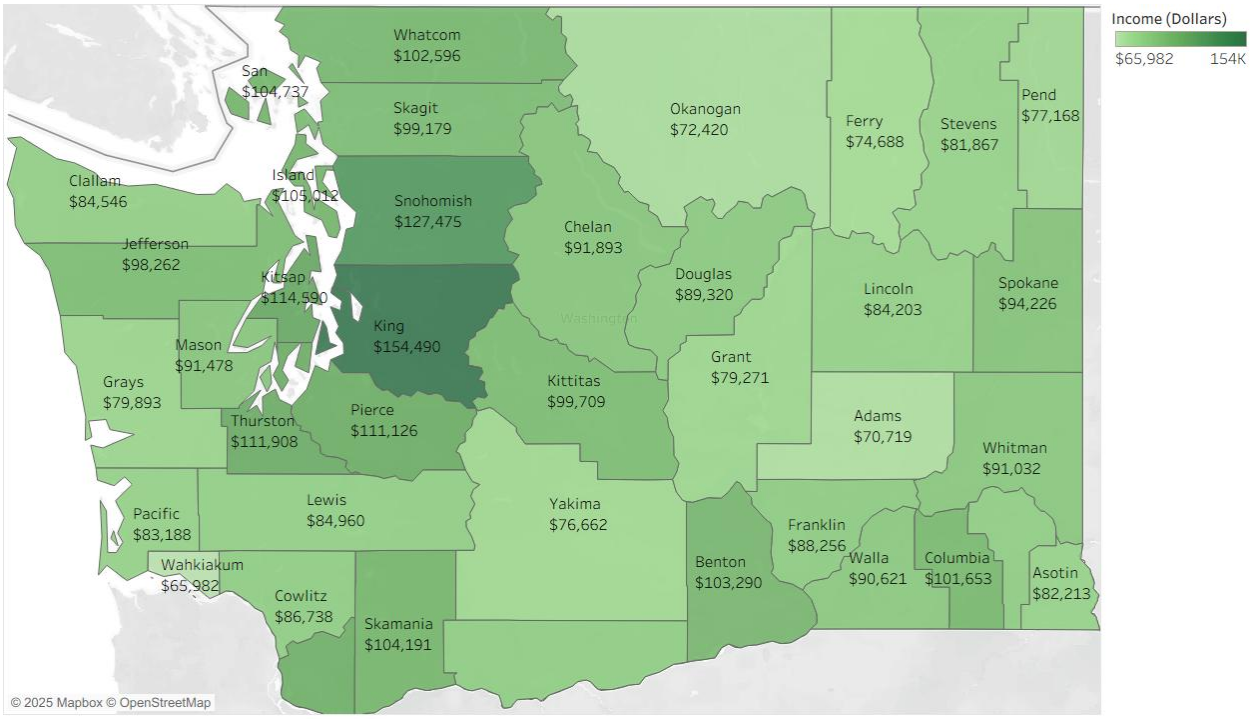
Map based on Longitude (generated) and Latitude (generated). Color shows sum of Population. The marks are labeled by County (Sheet1), sum of Population and sum of % Of State Population. Details are shown for County (Sheet1).



Map based on Longitude (generated) and Latitude (generated). Color shows sum of Population. The marks are labeled by County (Sheet1), sum of Population and sum of % Of State Population. Details are shown for County (Sheet1).



The trend of count of Vehicle_Registration_Transactions_by_Department_of_Licensing_20251122.csv for Model Year Quarter. Color shows details about Electrification Level (group). The marks are labeled by count of Vehicle_Registration_Transactions_by_Department_of_Licensing_20251122.csv. The view is filtered on Electrification Level (group), which excludes Not Applicable.



Map based on Longitude (generated) and Latitude (generated). Color shows median of Value (Dollars). The marks are labeled by sum of Value (Dollars) and County (HDPulse data export.csv). The data is filtered on income category, which keeps High Income, Low Income, Middle Income and Very High Income.

Recommendations:

Based on the findings, the following recommendations can enhance EV adoption:

1. Strengthen Infrastructure in Low-Adoption Counties

- Expand charging stations in rural and low-population counties (e.g., Garfield, Wahkiakum).
- Prioritize fast chargers along key commuting routes.

2. Incentivize Affordability

- Provide targeted subsidies or tax credits for low-income households.
- Encourage the availability of affordable EV models in rural dealerships.

3. Tailored Awareness Campaigns

- Launch local awareness programs addressing misconceptions about EV range, reliability, and cost savings.
- Create county-specific campaigns aligned with political and cultural attitudes.

4. Enhance Public-Private Partnerships

- Collaborate with automakers and private companies to expand EV fleets.
- Encourage workplaces to install charging points.

5. Data-Driven Policy Planning

- Use county-level data to tailor state policies.
- Prioritize counties showing the largest gap between ICE and EV registrations.

6. Promote Hybrid Vehicles as Transition Options

- Position hybrids as an intermediate step for counties hesitant to adopt full EVs.

Tools &amp:

Tableau

Future Improvements:

- Knowing the citizen's behavior
- See footprint effects for each type of vehicle

References

(n.d.). Retrieved from https://www.washingtonpolicy.org/publications/detail/results-of-washingtons-ev-instant-rebate?gad_source=1&gad_campaignid=21887239327&gbraid=0AAAADbzGwEZuGCU3yr--QjoBM_kXsBd&gclid=CjwKCAiA_orJBhBNEiwABkdmjCQHX3gNBzpzueIoGRxLIox3WRv7XMvNZVsbtoktR2_LEiFcY

(n.d.). Retrieved from https://hdpulse.nimhd.nih.gov/dictionary.php#income

(n.d.). Retrieved from https://www.theepochtimes.com/bright/electric-vehicles-the-good-the-bad-and-the-ugly-2-post-5861200?utm_medium=DigitalMkt&utm_source=google&utm_campaign=PM_max-content_JaneAusten-mik-20251118&gl=reg&gad_source=1&gad_campaignid=23282724121&gbraid=0AAAAACvu

(n.d.). Retrieved from https://www.instituteforenergyresearch.org/regulation/washington-states-ev-rebate-program-is-costly-and-has-missed-its-expected-goals/?gad_source=1&gad_campaignid=22522217224&gbraid=0AAAADhYN4EWSzpMwhAaNwkzElGXSFKB6&gclid=Cj0KCQiAoZDJBhC0ARIsAERP-F9rL5ho

(n.d.). Retrieved from https://www.kaggle.com/datasets/liamarguedas/washington-electric-vehicle-population/data

(n.d.). Retrieved from https://catalog.data.gov/dataset/vehicle-registrations-by-class-and-county

(n.d.). Retrieved from https://data.wa.gov/Transportation/Electric-Vehicle-Population-Size-History-by-County/q5qv-gkcz

(n.d.). Retrieved from https://hdpulse.nimhd.nih.gov/data-portal/social/map?age=001&age_options=ageall_1&demo=00011&demo_options=income_3&race=00&race_options=race_7&sex=0&sex_options=sexboth_1&socialtopic=030&socialtopic_options=social_6&statefips=53&statefips_options=area_sta

(n.d.). Retrieved from https://waevinstantrebates.org/program-results/

EVs — The Good, the Bad, and the Ugly (2025). [Motion Picture].