

Google Data Analytics Professional Capstone

Own Case Study: Electric Vehicle Adoption Analysis

Introduction

Scenario

You are a **junior data analyst working as a business intelligence consultant**. You have been assigned to support a new client: a **state transportation and energy planning agency** that is monitoring the growth of electric vehicle adoption.

The agency is interested in understanding:

- How electric vehicles are distributed across different regions
- Which types of electric vehicles are most commonly registered
- Trends in manufacturers and vehicle characteristics such as electric range and model year

These insights will help inform **infrastructure planning, sustainability initiatives, and future transportation policies**. Your task is to analyze electric vehicle registration data and present clear, data-driven findings that can be easily understood by non-technical stakeholders.

I. Ask

To guide the analysis, the following questions were identified:

1. What types of electric vehicles (Battery Electric Vehicles vs. Plug-in Hybrid Electric Vehicles) are most commonly registered?
2. How does electric vehicle adoption vary by geographic location?
3. How have electric vehicle characteristics, such as electric range, changed across model years?
4. Which manufacturers dominate electric vehicle registrations?
5. How can these trends inform future transportation and infrastructure planning?

II. Prepare

Data Source: This data is sourced from “data.gov” which is a public dataset by the State of Washington (Downloaded in December 29. 2025). (<https://catalog.data.gov/dataset/electric-vehicle-population-data>) Click here for more information.

Data Information: The file contains 16 columns which hold data about the necessary for analysis. The column names are below

| Original Column Names | Renamed Columns | Description |
|--|----------------------|--|
| VIN (1-10) | vin_1_10 | Vehicle Identification Number (VIN). ID per Vehicle |
| County | county | The county where the vehicle resides |
| City | city | The city where the vehicle resides |
| State | state | The state where the vehicle is registered |
| Postal Code | postal_code | The 5-digit ZIP code associated with the vehicle's registration address. |
| Model Year | model_year | The manufacturing year of the vehicle |
| Make | make | The manufacturer or brand name of the vehicle |
| Model | model | The specific model name of the vehicle |
| Electric Vehicle Type | ev_type | Electric Vehicle (EV). Battery Electric Vehicle (BEV) or a Plug-in Hybrid Electric Vehicle (PHEV). |
| Clean Alternative Fuel Vehicle (CAFV) Eligibility | caf_v_eligibility | Categorizes the vehicle's eligibility for Clean Alternative Fuel Vehicle based on range and fuel requirements. |
| Electric Range | electric_range | The maximum number of miles the vehicle can travel purely on electric power, based on EPA ratings. |
| Legislative District | legislative_district | The specific Washington State legislative district where the vehicle's owner resides. |
| DOL Vehicle ID | dol_vehicle_id | A unique identification number assigned to each specific vehicle by the Washington Department of Licensing. |

| | | |
|--------------------------|-------------------|---|
| Vehicle Location | vehicle_location | The geographic center point (latitude/longitude) of the ZIP code where the vehicle is registered. |
| Electric Utility | electric_utility | The electric power provider serving the area of the vehicle's registration address. |
| 2020 Census Tract | census_tract_2020 | The 2020 Census Tract identifier used for mapping the vehicle's location to specific demographic areas. |

ROCCC Assessment:

- **Reliable:** Sourced from official government data.
- **Original:** Sourced directly from the state licensing agency.
- **Comprehensive:** It includes Make, Model, Range, County, and Legislative District.
- **Current:** This dataset is typically updated monthly.
- **Cited:** It is a public record available on Data.gov.

Data Organization: The data is structured in a CSV format with columns representing vehicle attributes (VIN, Location, EV Type, etc.).

III. Process

Schema Standardization

The original dataset contained headers with spaces and special characters (e.g., "VIN (1-10)", "Clean Alternative Fuel Vehicle Eligibility"), which are incompatible with SQL syntax.

- **Action:** Column headers were converted to snake_case (lowercase with underscores) to align with industry standard naming conventions.
- **Example:** VIN (1-10) became vin_1_10 and Vehicle Location became vehicle_location.

Feature Selection

| Column | Description |
|----------------|---|
| vin_1_10 | Chosen the latest VINs. |
| county | Which county the car resides in. |
| state | Which state of the vehicle resides in (Exclusively for the state of Washington) |
| model_year | Year of the model car |
| make | Brand or Manufacturer |
| ev_type | Battery Electric Vehicle (BEV) or a Plug-in Hybrid Electric Vehicle (PHEV). |
| electric_range | Range of the EV |

To optimize processing and maintain focus on the business task, several columns were excluded from the analysis.

- **Excluded Fields:** legislative_district, electric_utility, census_tract, and full_vehicle_identification_numbers.

These fields provided additional information about the actual vehicle that was not required to analyze regional distribution or manufacturer trends, and their removal improved query performance.

Data Cleaning and Deduplication (SQL)

```
CREATE TABLE `capstone-482707.EV_data.cleaned_ev_final2` AS
SELECT
  vin_1_10,
  UPPER(TRIM(county)) AS county,
  state,
  model_year,
  UPPER(TRIM(make)) AS make,
  upper(trim(ev_type)) AS ev_type,
  CAST(electric_range AS INT) AS electric_range
FROM (
  SELECT *,
    ROW_NUMBER() OVER (
      PARTITION BY vin_1_10
      ORDER BY county IS NOT NULL DESC
    ) AS row_num
  FROM `capstone-482707.EV_data.EV_data`
  WHERE state = 'WA'
  AND UPPER(TRIM(ev_type)) IN (
    'BATTERY ELECTRIC VEHICLE (BEV)',
    'PLUG-IN HYBRID ELECTRIC VEHICLE (PHEV)'
  )
)
WHERE row_num = 1
AND vin_1_10 IS NOT NULL
AND county IS NOT NULL
AND model_year IS NOT NULL
AND make IS NOT NULL
AND ev_type IS NOT NULL;
```

A comprehensive SQL script was executed to filter the dataset and ensure record uniqueness. The following transformations were applied:

1. **Geographic Filtering:** The scope was limited to the state of **Washington (WA)**.
2. **Vehicle Classification:** Data was restricted to "Battery Electric Vehicles (BEV)" and "Plug-in Hybrid Electric Vehicles (PHEV)." Removed Clean Alternative Fuel Vehicle (CAFV) Eligibility since the cars are already registered and the new models have not been tested for their range, but the official sources cite their nature as BEV and PHEV
3. **Handling Duplicates:** To ensure data integrity, the ROW_NUMBER() window function was used to partition by dol_vehicle_id. This ensured that each vehicle registration was unique, picking the most recent record by model_year.
4. **Null Value Management:** Records missing critical geographic data (county or city) were removed to ensure the accuracy of the regional distribution analysis.

```
FROM (
SELECT *,
ROW_NUMBER() OVER (
PARTITION BY vin_1_10
ORDER BY county IS NOT NULL DESC
) AS row_num
```

As for the case of VIN duplicates, some vehicles appeared multiple times in the dataset due to registration updates. To avoid overcounting, each vehicle was represented only once using its most recent record.

```
tesla_trend <- cleaned_ev_data %>%
  filter(ev_type == "BATTERY ELECTRIC VEHICLE (BEV)") %>%
  filter(electric_range > 0) %>%
  filter(make == "TESLA") %>%
  group_by(model_year) %>%
  summarize(
    avg_range_miles = mean(electric_range),
    avg_range_km = avg_range_miles * 1.609344
  )
```

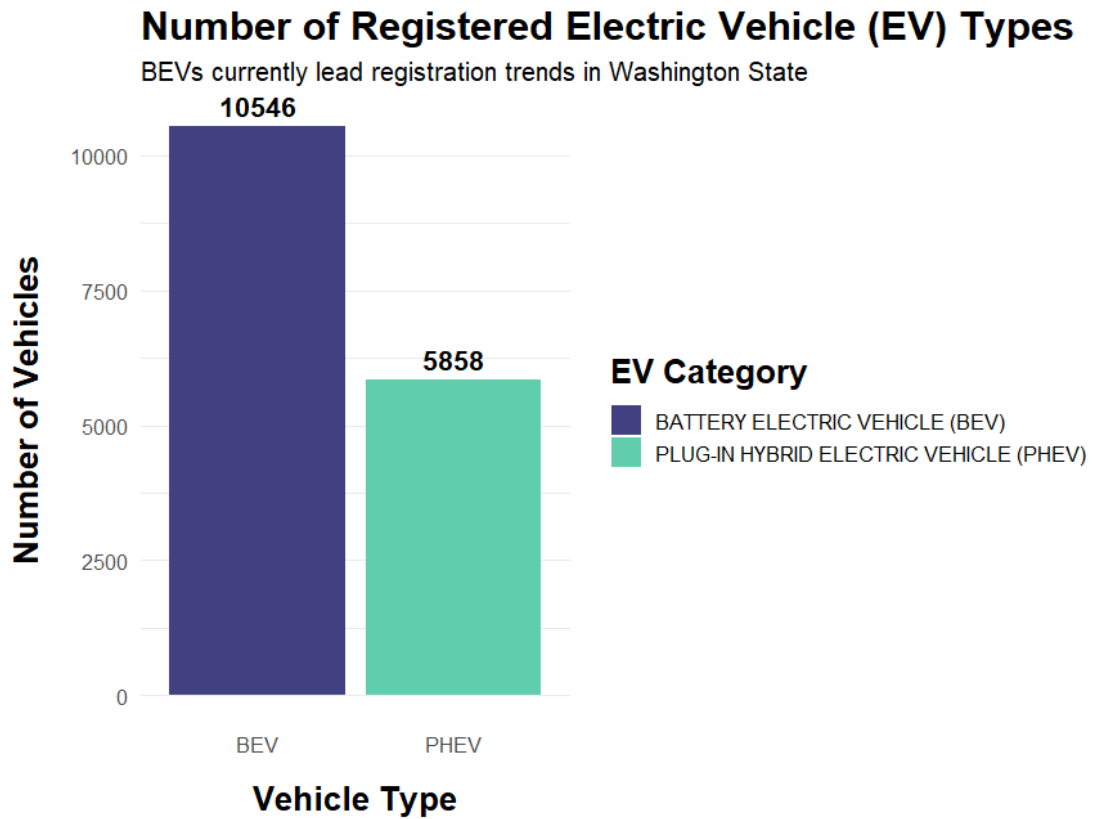
The R command to separate the Tesla Models only, in order to showcase the large impact made by Tesla in the BEV category.

```
SELECT
COUNT(*) AS BEV_num,
COUNTIF(make = "TESLA") AS tesla_vehicles,
ROUND(COUNTIF(make = "TESLA") * 100.0 / COUNT(*), 2) AS tesla_percentage
FROM `capstone-482707.EV_data.EV_data`
where ev_type = "Battery Electric Vehicle (BEV)";
```

With Tesla making up 51.45% of BEVs (111,049 out of 215,859) and leading in range and affordability, a separate graph was created to show its impact in the BEV market.

IV. Analyze

Vehicle Type Distribution:



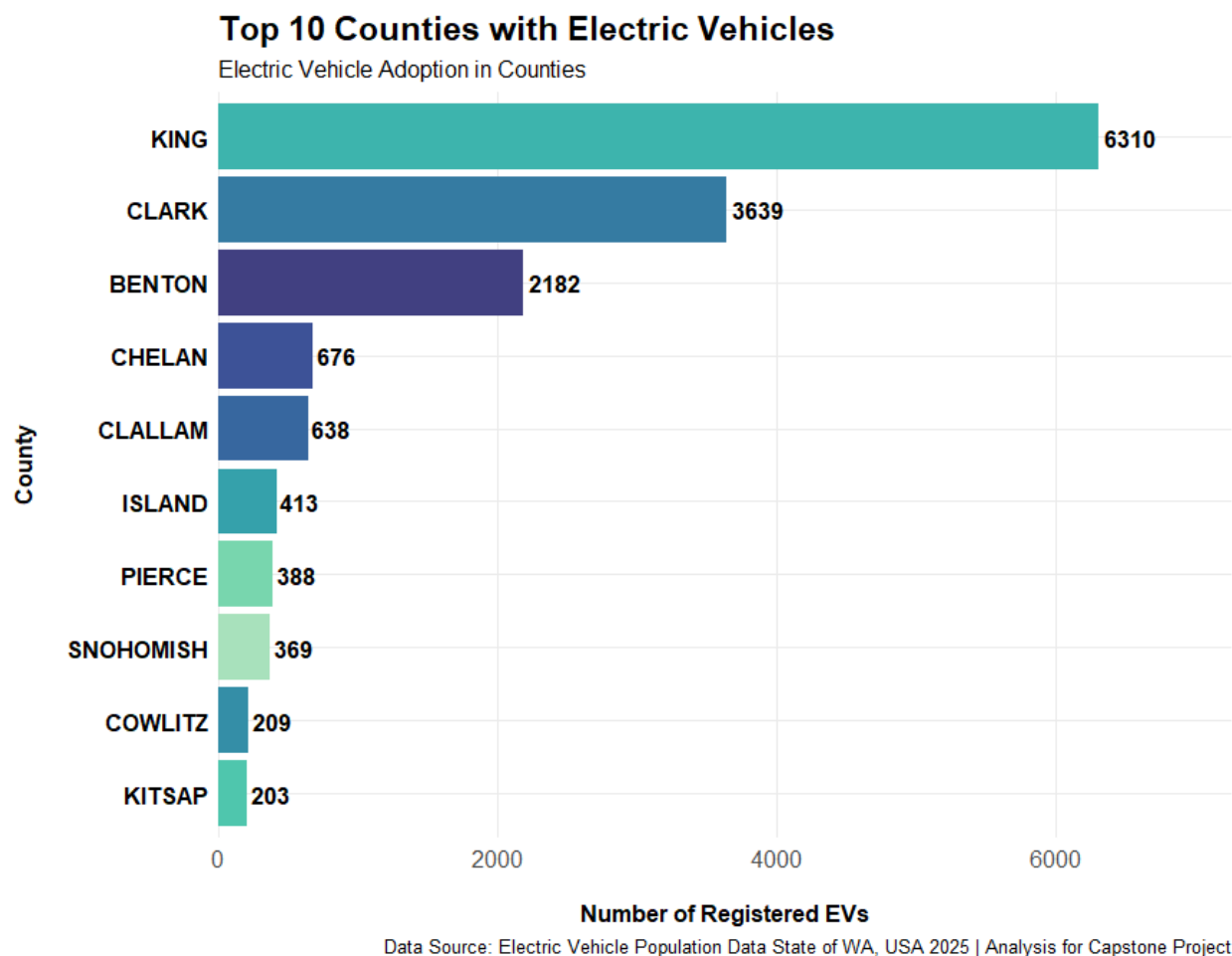
Data Source: Electric Vehicle Population Data State of WA, USA 2025 | Analysis for Capstone Project

Battery Electric Vehicles (BEVs) are the most commonly registered type in Washington, with 10,546 registrations compared to 5,858 for Plug-in Hybrid Electric Vehicles (PHEVs).

Registered BEVs lead in total volume, while PHEVs currently account for approximately half of that amount.

The statistics also included the registered cars with 0 ranges, which are presumed to be the new models that their range have not been properly recorded as of now.

Geographic Adoption:



Electric vehicle adoption is highly concentrated in specific regions. **King County** leads with 6,310 registrations, followed by **Clark** (3,639) and **Benton** (2,182). These top three counties represent the primary hubs for EV adoption in the state.

The high concentration of electric vehicle (EV) registrations in **King, Clark, and Benton counties** is driven by a combination of urban density, socio-economic factors, and strategic infrastructure investment supported by state and utility planning initiatives [1].

King County leads EV adoption statewide, accounting for the largest share of registered electric vehicles in Washington. This dominance is supported by state registration data and reflects the county’s role as a major urban and economic center with extensive public charging infrastructure and long-standing sustainability programs [2].

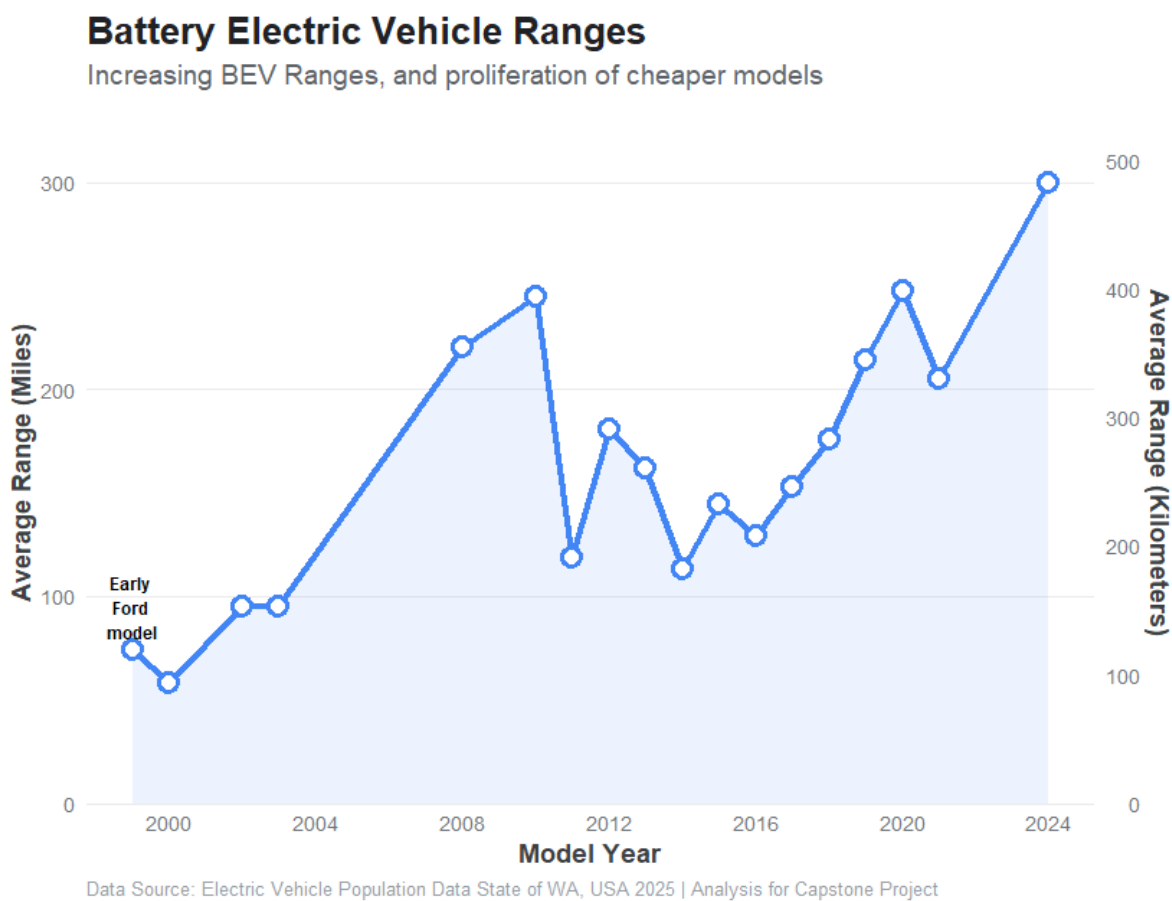
Clark County’s EV adoption growth is strongly influenced by commuter behavior and utility-driven electrification efforts. Clark Public Utilities identifies increasing EV registrations as a

key driver for expanded charging infrastructure, residential incentives, and grid-readiness planning to support suburban and cross-metro commuters [3].

Benton County functions as the primary EV adoption hub in Eastern Washington due to its location along designated **Alternative Fuel Corridors**, particularly I-82 and I-182. State infrastructure planning documents prioritize these corridors to reduce range anxiety and support regional EV travel, reinforcing Benton County’s strategic importance despite its lower population density [1].

Evolution of Electric Range:

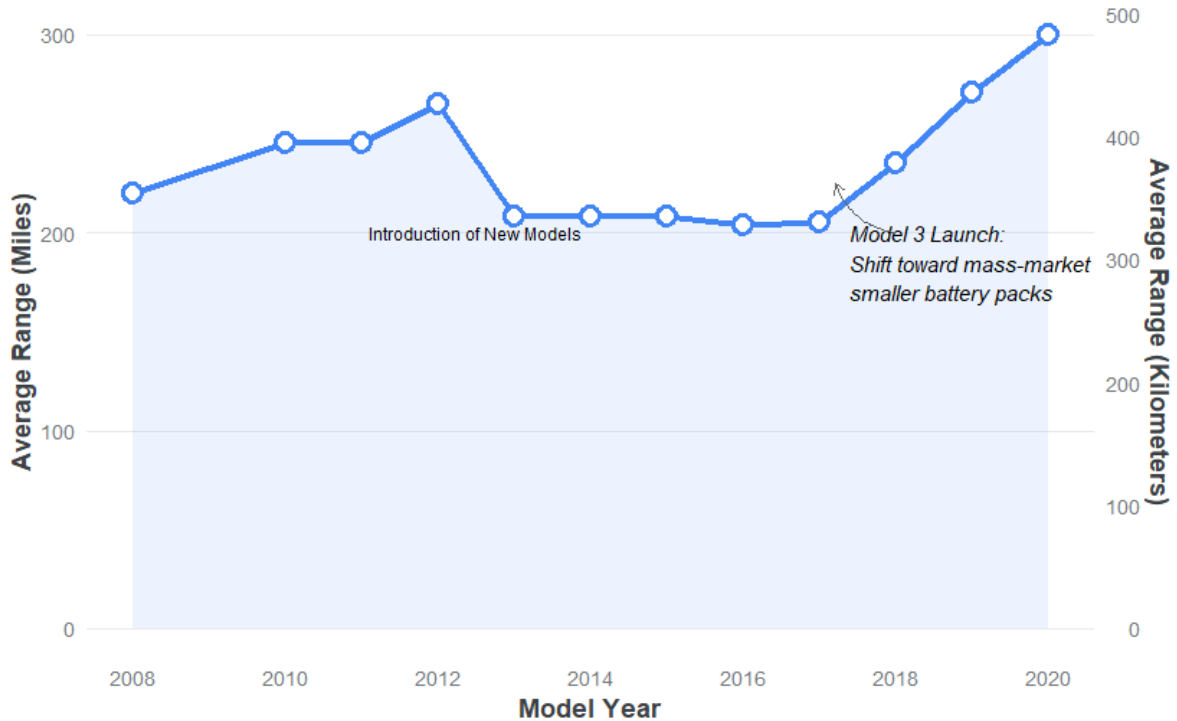
In this phase, newly registered electric vehicles with 0 electric ranges were removed to prevent the results from skewing.



BEV ranges have seen significant growth over time. While early models (such as the first Ford BEV) had higher ranges than previous cars but faced various limitations [4], the industry saw a "huge rise" in average range largely driven by Tesla models that outpaced competitors.

Average Range of Tesla Cars over the Years

The 2017 dip reflects the launch of the Model 3, offering a more affordable entry in the state of WA.



Data Source: Electric Vehicle Population Data State of WA, USA 2025 | Analysis for Capstone Project

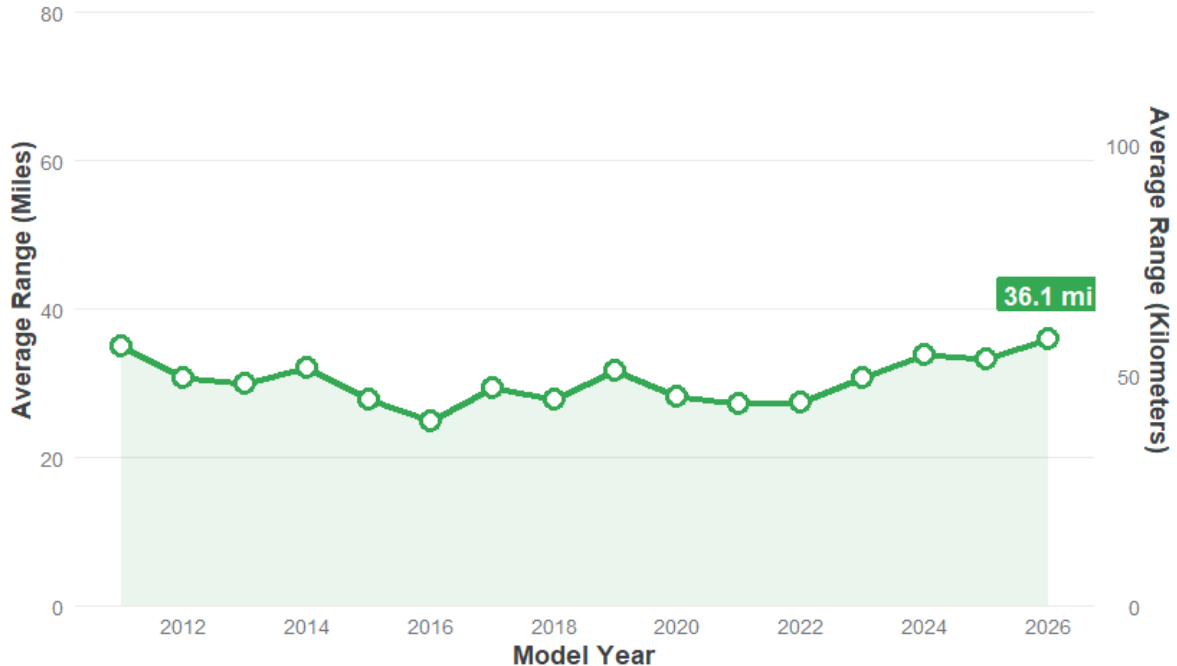
For Tesla specifically, while overall range has increased, the 2017 dip in average range reflects a strategic shift toward mass-market affordability with the launch of the **Model 3**, which utilized smaller battery packs.

In seeing tesla, the range increased as well, but the introduction of cheaper models gave affordability but also at a lower range.

The upward trend of ranges shows that technology enabled affordable with a greater range from previous models, newer models are also present, but the dataset did not provide their official ranges and thus were excluded from the data processing.

Plug-in Hybrid Electric Vehicles(PHEV): Electric Motor Range

Electric Motor Range. Commonly used in tandem with the main engine or driving quietly



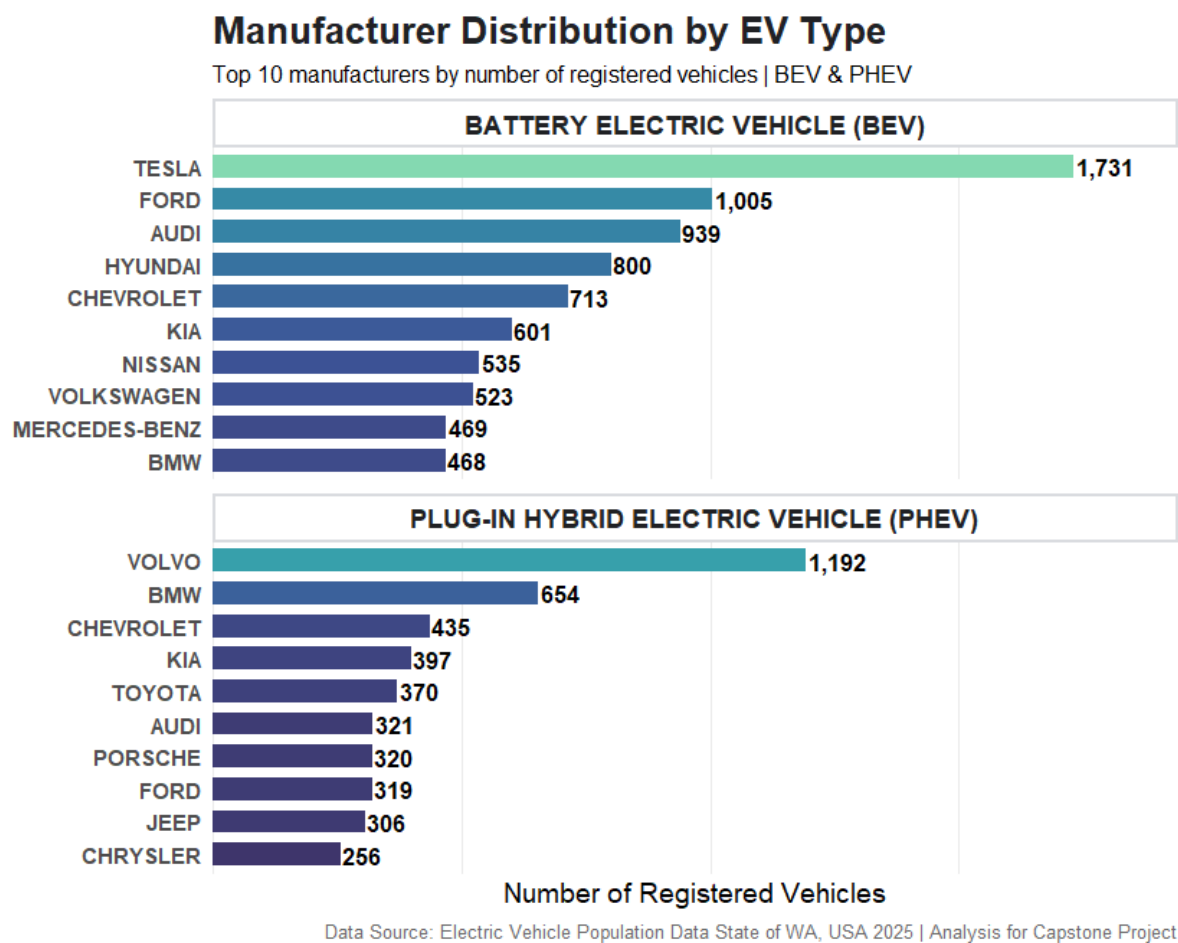
Note: Early year variability is driven by low-volume, high-performance models.

Data Source: Electric Vehicle Population Data State of WA, USA 2025 | Analysis for Capstone Project

In PHEVs, the range of the electric motor shows a gradual improvement, the dips and rise shows the introduction of different kinds of models, but remained relatively similar. PHEVs have low electric range because their batteries are designed for short-range electrification, with the motor serving mainly as secondary propulsion for eco-mode or quiet driving rather than as the primary power source.”

One vehicle record (Wheego) reported a 100-mile electric range under the plug-in hybrid category. External references indicate that Wheego vehicles are battery electric rather than plug-in hybrids. To avoid inflating PHEV range estimates while maintaining the integrity of the original dataset, this record was excluded from PHEV range analysis rather than reclassified. Additionally, the Wheego vehicle is a compact, low-range electric vehicle whose reported range is substantially lower than that of dominant battery electric vehicles such as Tesla models. Because of its relatively small market presence and lower range, retaining it without reclassification does not significantly affect overall trends in electric vehicle range evolution.

Manufacturer Leadership:

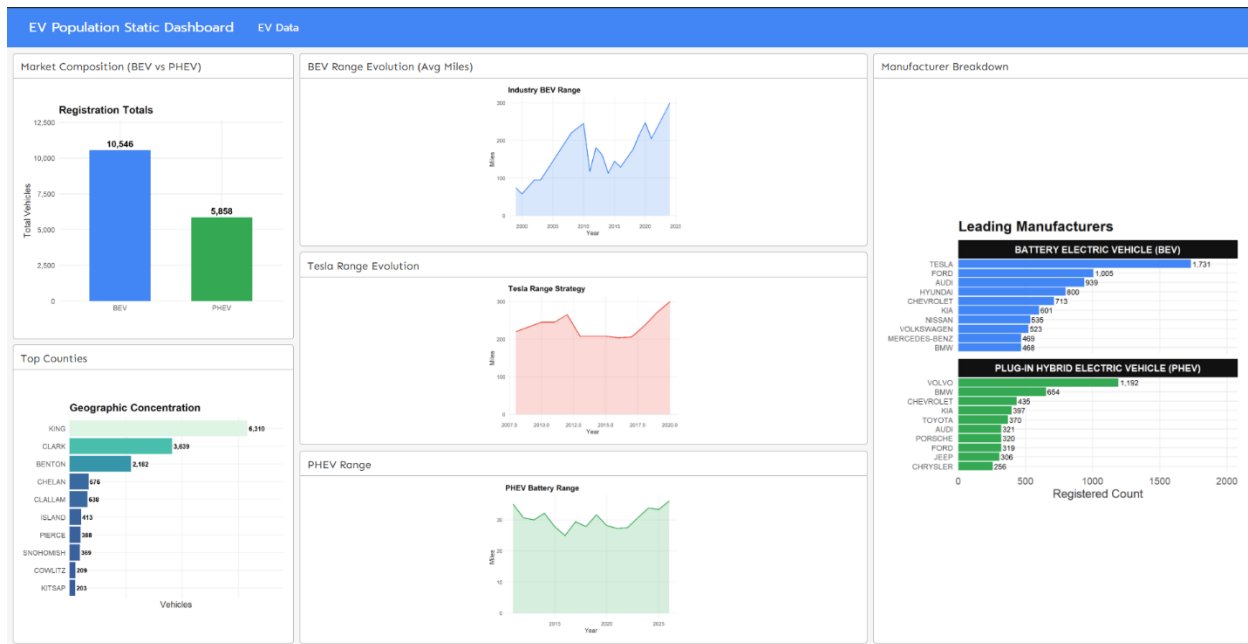


Consumer preference varies significantly by EV type. **Tesla** dominates the BEV category (1,731 registrations in the analyzed set) due to its established reputation and range.

In the PHEV category, **Volvo** is the leading manufacturer (1,192 registrations), suggesting a different market leader for hybrid technology.

These are the top 10 leading manufacturers for each which shows the preference for each EV type, like as previously mentioned, in the BEV category, Tesla is popular due to its reputation and range, and in the PHEV category, Volvo seems to lead in that category.

V. Share



This dashboard provides a snapshot of the current electric vehicle (EV) landscape in Washington State. It is designed to assist the agency in targeting infrastructure investments and understanding consumer technology trends.

The market composition of EVs leans towards **Battery Electric Vehicles (BEVs)**, BEVs significantly outnumber Plug-in Hybrid Electric Vehicles (PHEVs) by nearly a 2-to-1 margin (10,546 BEVs vs. 5,858 PHEVs).

Adoption is highly centralized. **King, Clark, and Benton** counties represent the primary hubs, indicating where immediate grid reinforcement and charging density are most critical.

BEV technology is maturing rapidly. **Average ranges** have **trended steeply upward to nearly 300 miles**, suggesting that **long-distance travel is becoming increasingly feasible** for Washington residents or the battery technology has matured enough.

The EV market has a preference for Tesla (1,731 vehicles) which are followed by legacy car makers, and in the Plug-in Hybrid Electric Vehicle (PHEV) market, Volvo (1,192 vehicles) remains a popular choice.

VI. Act

From the analysis of the trends in the EV adoption rate in the state of Washington. Here are the following recommendations:

1. **Accelerate Fast Charging Infrastructure:** Prioritize the deployment of **Level 3 DC Fast Charging** stations to meet the needs of the growing Battery Electric Vehicle (BEV) population. To ensure future-proof accessibility, all new installations should adopt **universal standards**, including North American Charging Standard (**NACS**) (Tesla's standard) and Combined Charging System (**CCS**) connectors.

2. **Strategic Regional Scaling:** While King County remains the state's volume leader, **Benton County** serves as a vital **geographic bridge** for cross-state travel corridors. **Maintain investments** such as upgrading to **fast charging stations** in high-volume areas like **King** and **Clark** while specifically **increasing the density of charging stations in Benton County** to eliminate range anxiety for long-distance travelers.

3. **Balanced Placement for Future Development:** While vehicle ranges are increasing, infrastructure must follow a **"middle-ground" placement strategy** to cater to current and future needs. High-density station placement is necessary to support current and budget-friendly EV models with lower ranges, ensuring they are not stranded. Simultaneously, as the total volume of EVs, such as those with longer ranges which are expected to grow exponentially in the future, maintaining a denser network of stations will be critical to prevent bottlenecks and provide the necessary charging capacity for a mass-market fleet.

For future actions, wait for the updated EV dataset for further analysis.

References

- [1] Washington State Department of Transportation (WSDOT), *Washington State Plan for Electric Vehicle Infrastructure Deployment*, July 2022. [Online]. Available: <https://wsdot.wa.gov/sites/default/files/2022-08/Electricvehicle-plan-infastructuredeployment.pdf>
- [2] Washington State Department of Transportation (WSDOT), *Electric Vehicle Registrations — Washington State (Gray Notebook)*. [Online]. Available: <https://wsdot.wa.gov/about/data/gray-notebook/gnbhome/environment/electricvehicles/electricvehicles.htm>
- [3] Clark Public Utilities, *2024 Transportation Electrification Plan Update*, Jan. 2024. [Online]. Available: <https://www.clarkpublicutilities.com/wp-content/uploads/2024/01/2024-Transportation-Electrification-Plan-Update.pdf>
- [4] “Ford Ranger EV,” *Wikipedia*, 2025. [Online]. Available: https://en.wikipedia.org/wiki/Ford_Ranger_EV (I know citing Wikipedia is not a good practice, but I can’t find (or too lazy) to find other official sources where the issues are talked about)

