Electric Vehicles Market

Market size analysis for electric vehicles involves a multi-step process that includes defining the market scope, collecting and preparing data, analytical modeling, and communicating findings through visualization and reporting.

1. Define whether the analysis is global, regional, or focused on specific countries.
2. Gather information from industry associations, market research firms (e.g., BloombergNEF, IEA), and government publications relevant to the EV market.
3. Use historical data to identify EV sales, production, and market trends.
4. Analyze the market size and growth rates for different EV segments.
5. Based on the market size analysis, provide strategic recommendations for businesses looking to enter or expand in the EV market.

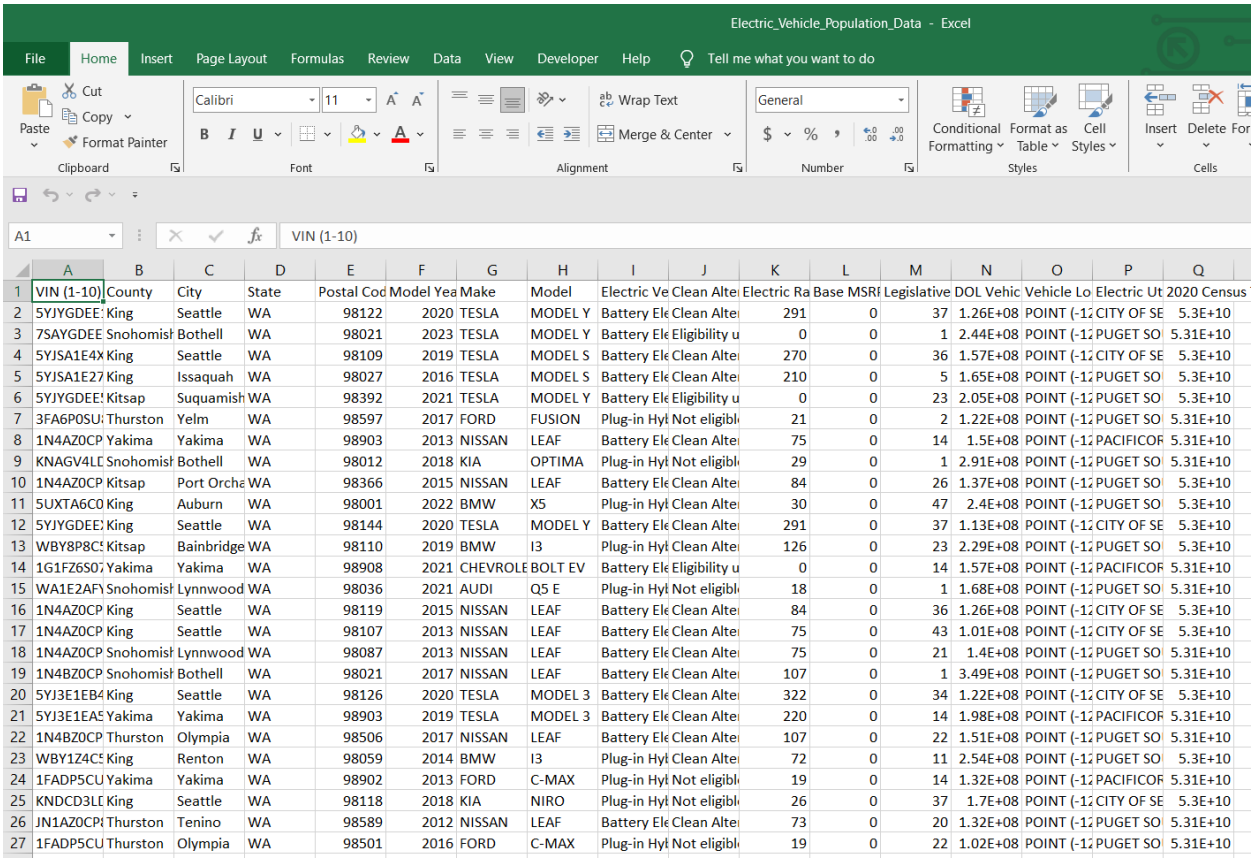
Data description of the data set of column

1. VIN (1-10): Partial Vehicle Identification Number.
2. County: The county in which the vehicle is registered.
3. City: The city in which the vehicle is registered.
4. State: The state in which the vehicle is registered. It appears that this dataset may be focused on Washington (WA) state.
5. Postal Code: The postal code where the vehicle is registered.
6. Model Year: The year of the vehicle model.
7. Make: The manufacturer of the vehicle.
8. Model: The model of the vehicle.
9. Electric Vehicle Type: The type of electric vehicle, e.g., Battery Electric Vehicle (BEV).
10. Clean Alternative Fuel Vehicle (CAFV) Eligibility: Eligibility status for clean alternative fuel vehicle programs.
11. Electric Range: The maximum range of the vehicle on a single charge (in miles).
12. Base MSRP: The Manufacturer's Suggested Retail Price.
13. Legislative District: The legislative district where the vehicle is registered.
14. DOL Vehicle ID: Department of Licensing Vehicle Identification.
15. Vehicle Location: Geographic coordinates of the vehicle location.
16. Electric Utility: The electric utility service provider for the vehicle's location.
17. 2020 Census Tract: The census tract for the vehicle's location.

Table 5.1: Data description

DATA VISUALIZATION AND ANALYSIS

We will be analyzing the data with the help of some questions. Below is the figure of the datasheet in excel that will give you the hint that how the data is available to us.



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	VIN (1-10)	County	City	State	Postal Cod	Model Yea	Make	Model	Electric Ve	Clean Alte	Electric Ra	Base MSRI	Legislative	DOL Vehic	Vehicle Lo	Electric Ut	2020 Census
2	5YJYGDEE	King	Seattle	WA	98122	2020	TESLA	MODEL Y	Battery Ele	Clean Alte	291	0	37	1.26E+08	POINT (-12	CITY OF SE	5.3E+10
3	7SAYGDEE	Snohomish	Bothell	WA	98021	2023	TESLA	MODEL Y	Battery Ele	Eligibility u	0	0	1	2.44E+08	POINT (-12	PUGET SO	5.31E+10
4	5YJSA1E4X	King	Seattle	WA	98109	2019	TESLA	MODEL S	Battery Ele	Clean Alte	270	0	36	1.57E+08	POINT (-12	CITY OF SE	5.3E+10
5	5YJSA1E27	King	Issaquah	WA	98027	2016	TESLA	MODEL S	Battery Ele	Clean Alte	210	0	5	1.65E+08	POINT (-12	PUGET SO	5.3E+10
6	5YJYGDEE	Kitsap	Suquamish	WA	98392	2021	TESLA	MODEL Y	Battery Ele	Eligibility u	0	0	23	2.05E+08	POINT (-12	PUGET SO	5.3E+10
7	3FA6P0SU	Thurston	Yelm	WA	98597	2017	FORD	FUSION	Plug-in Hyl	Not eligibl	21	0	2	1.22E+08	POINT (-12	PUGET SO	5.31E+10
8	1N4AZ0CP	Yakima	Yakima	WA	98903	2013	NISSAN	LEAF	Battery Ele	Clean Alte	75	0	14	1.5E+08	POINT (-12	PACIFICOR	5.31E+10
9	KNAGV4LE	Snohomish	Bothell	WA	98012	2018	KIA	OPTIMA	Plug-in Hyl	Not eligibl	29	0	1	2.91E+08	POINT (-12	PUGET SO	5.31E+10
10	1N4AZ0CP	Kitsap	Port Orcha	WA	98366	2015	NISSAN	LEAF	Battery Ele	Clean Alte	84	0	26	1.37E+08	POINT (-12	PUGET SO	5.3E+10
11	5UXTA6C0	King	Auburn	WA	98001	2022	BMW	X5	Plug-in Hyl	Clean Alte	30	0	47	2.4E+08	POINT (-12	PUGET SO	5.3E+10
12	5YJYGDEE	King	Seattle	WA	98144	2020	TESLA	MODEL Y	Battery Ele	Clean Alte	291	0	37	1.13E+08	POINT (-12	CITY OF SE	5.3E+10
13	WBY8P8C5	Kitsap	Bainbridge	WA	98110	2019	BMW	I3	Plug-in Hyl	Clean Alte	126	0	23	2.29E+08	POINT (-12	PUGET SO	5.3E+10
14	1G1FZ6S0	Yakima	Yakima	WA	98908	2021	CHEVROLE	BOLT EV	Battery Ele	Eligibility u	0	0	14	1.57E+08	POINT (-12	PACIFICOR	5.31E+10
15	WA1E2AF	Snohomish	Lynnwood	WA	98036	2021	AUDI	Q5 E	Plug-in Hyl	Not eligibl	18	0	1	1.68E+08	POINT (-12	PUGET SO	5.31E+10
16	1N4AZ0CP	King	Seattle	WA	98119	2015	NISSAN	LEAF	Battery Ele	Clean Alte	84	0	36	1.26E+08	POINT (-12	CITY OF SE	5.3E+10
17	1N4AZ0CP	King	Seattle	WA	98107	2013	NISSAN	LEAF	Battery Ele	Clean Alte	75	0	43	1.01E+08	POINT (-12	CITY OF SE	5.3E+10
18	1N4AZ0CP	Snohomish	Lynnwood	WA	98087	2013	NISSAN	LEAF	Battery Ele	Clean Alte	75	0	21	1.4E+08	POINT (-12	PUGET SO	5.31E+10
19	1N4BZ0CP	Snohomish	Bothell	WA	98021	2017	NISSAN	LEAF	Battery Ele	Clean Alte	107	0	1	3.49E+08	POINT (-12	PUGET SO	5.31E+10
20	5YJ3E1EB4	King	Seattle	WA	98126	2020	TESLA	MODEL 3	Battery Ele	Clean Alte	322	0	34	1.22E+08	POINT (-12	CITY OF SE	5.3E+10
21	5YJ3E1EA5	Yakima	Yakima	WA	98903	2019	TESLA	MODEL 3	Battery Ele	Clean Alte	220	0	14	1.98E+08	POINT (-12	PACIFICOR	5.31E+10
22	1N4BZ0CP	Thurston	Olympia	WA	98506	2017	NISSAN	LEAF	Battery Ele	Clean Alte	107	0	22	1.51E+08	POINT (-12	PUGET SO	5.31E+10
23	WBY1Z4C5	King	Renton	WA	98059	2014	BMW	I3	Plug-in Hyl	Clean Alte	72	0	11	2.54E+08	POINT (-12	PUGET SO	5.3E+10
24	1FADP5CU	Yakima	Yakima	WA	98902	2013	FORD	C-MAX	Plug-in Hyl	Not eligibl	19	0	14	1.32E+08	POINT (-12	PACIFICOR	5.31E+10
25	KNDCD3LE	King	Seattle	WA	98118	2018	KIA	NIRO	Plug-in Hyl	Not eligibl	26	0	37	1.7E+08	POINT (-12	CITY OF SE	5.3E+10
26	JN1AZ0CP	Thurston	Tenino	WA	98589	2012	NISSAN	LEAF	Battery Ele	Clean Alte	73	0	20	1.32E+08	POINT (-12	PUGET SO	5.31E+10
27	1FADP5CU	Thurston	Olympia	WA	98501	2016	FORD	C-MAX	Plug-in Hyl	Not eligibl	19	0	22	1.02E+08	POINT (-12	PUGET SO	5.31E+10

Figure 5.1: Electric Vehicle Production Data Sets

Analysis will be easier by giving explanation to the following set of questions.

1. Top 20 Counties by Electric Vehicle Counts.

```
In [1]: import numpy as np
        import pandas as pd
        import seaborn as sns
        import matplotlib.pyplot as plt
```

Figure 5.2: Importing the required packages

```
In [2]: df = pd.read_csv('F:\Deets Digital\Python\EV-data\\Electric_Vehicle_Population_Data.csv')
```

Figure 5.3: Reading the csv file

```
In [3]: df.head()
```

Out[3]:

	County	City	State	Postal Code	Model Year	Make	Model	Electric Vehicle Type	Clean Alternative Fuel Vehicle (CAFV) Eligibility	Electric Range	Base MSRP	Legislative District	DOL Vehicle ID	Vehicle Location	Electric Utility	2020 Census Tract
	King	Seattle	WA	98122.0	2020	TESLA	MODEL Y	Battery Electric Vehicle (BEV)	Clean Alternative Fuel Vehicle Eligible	291	0	37.0	125701579	POINT (-122.30839 47.610365)	CITY OF SEATTLE - (WA)|CITY OF TACOMA - (WA)	5.303301e+10
	ıohomish	Bothell	WA	98021.0	2023	TESLA	MODEL Y	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...	0	0	1.0	244285107	POINT (-122.179458 47.802589)	PUGET SOUND ENERGY INC	5.306105e+10
	King	Seattle	WA	98109.0	2019	TESLA	MODEL S	Battery Electric Vehicle (BEV)	Clean Alternative Fuel Vehicle Eligible	270	0	36.0	156773144	POINT (-122.34848 47.632405)	CITY OF SEATTLE - (WA)|CITY OF TACOMA - (WA)	5.303301e+10
	King	Issaquah	WA	98027.0	2016	TESLA	MODEL S	Battery Electric Vehicle (BEV)	Clean Alternative Fuel Vehicle Eligible	210	0	5.0	165103011	POINT (-122.03646 47.534065)	PUGET SOUND ENERGY INC||CITY OF TACOMA - (WA)	5.303303e+10

Figure 5.4: Use of head function

```
In [28]: # Top 20 countries by electric vehicle

ev_count_distributions = df1.groupby('County')['VIN (1-10)'].count().reset_index().sort_values(by = 'VIN (1-10)', ascending = Fal
top_20_coutries = ev_count_distributions.head(20)
```

```
In [27]: plt.figure(figsize=(10, 8))
         sns.barplot(x="VIN (1-10)", y='County', data=top_20_coutries, palette='viridis')
         plt.title('Top 20 Counties by Electric Vehicle Counts')
         plt.xlabel('Number of Electric Vehicles')
         plt.ylabel('County')
         plt.tight_layout()
         plt.show()
```

Figure 5.5: Plotting the graph

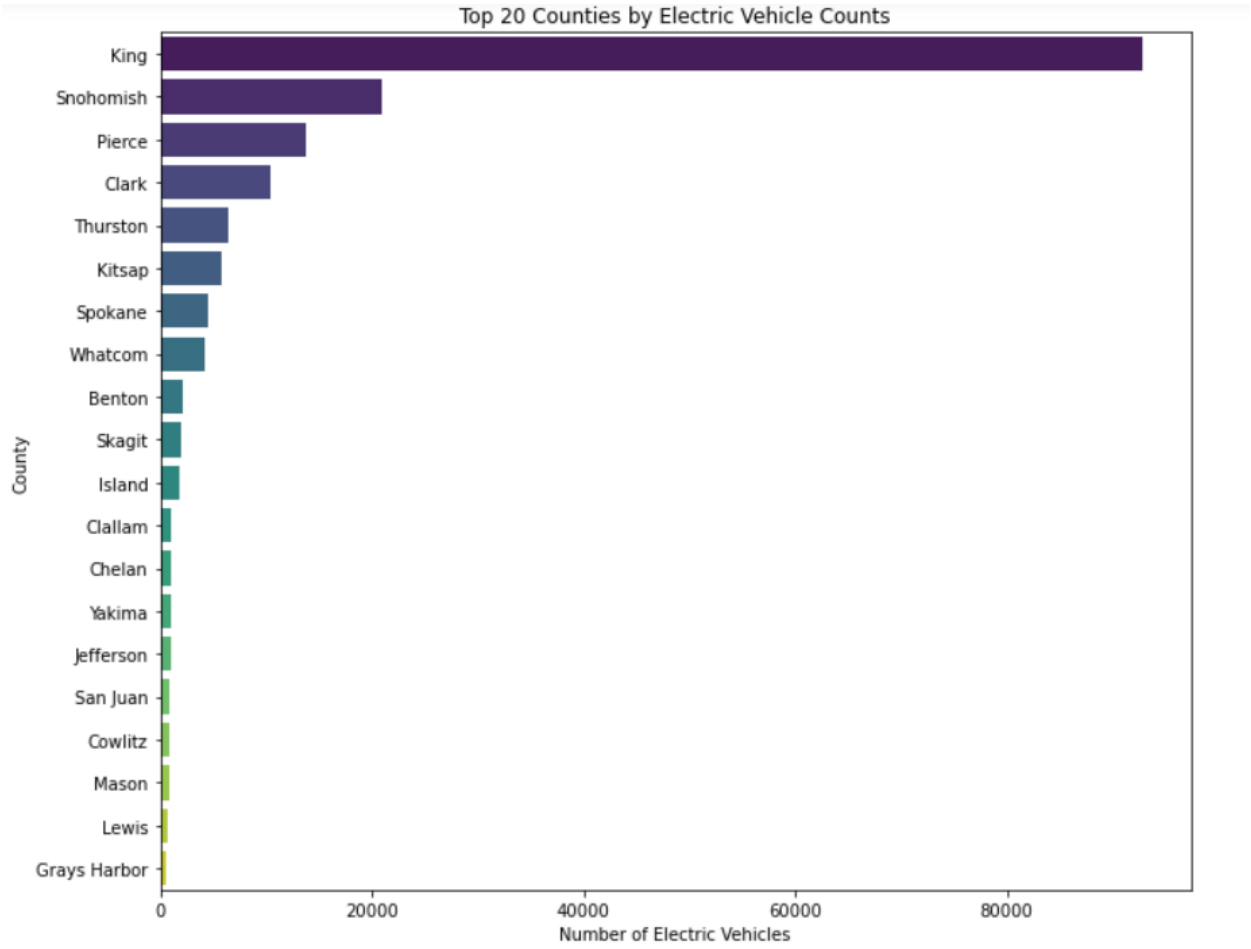


Figure 5.6: Top 20 counties by electric vehicle

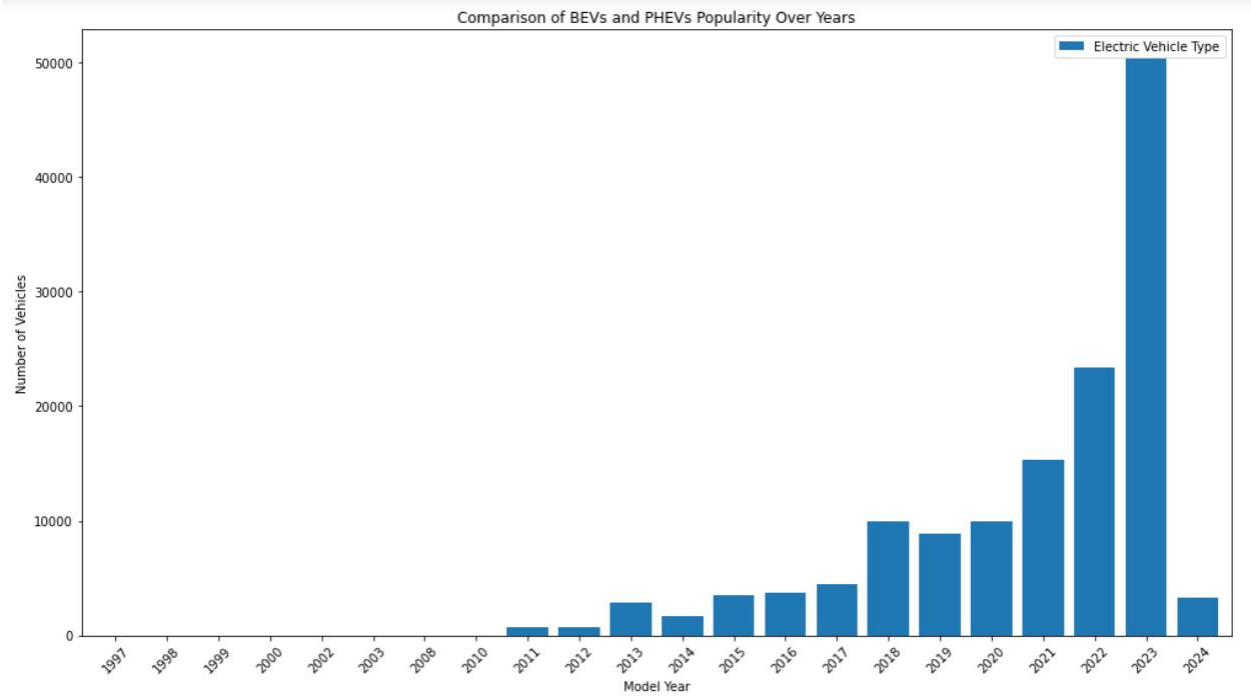
Conclusion: The visualization highlights King County as the leading region in electric vehicle adoption, followed by others like Snohomish and Pierce counties.

2. Comparison of BEVs and PHEVs Popularity Over Years

In [31]:
```
# comparing of BEV and PHEV Over years

ev_Bev_Phev = df1[df1['Electric Vehicle Type'].isin(['Battery Electric Vehicle (BEV)','Hybrid Electric Vehicle (PHEV)'])]
yearly_ev_counts =ev_Bev_Phev.groupby('Model Year')['Electric Vehicle Type'].count().reset_index()
```

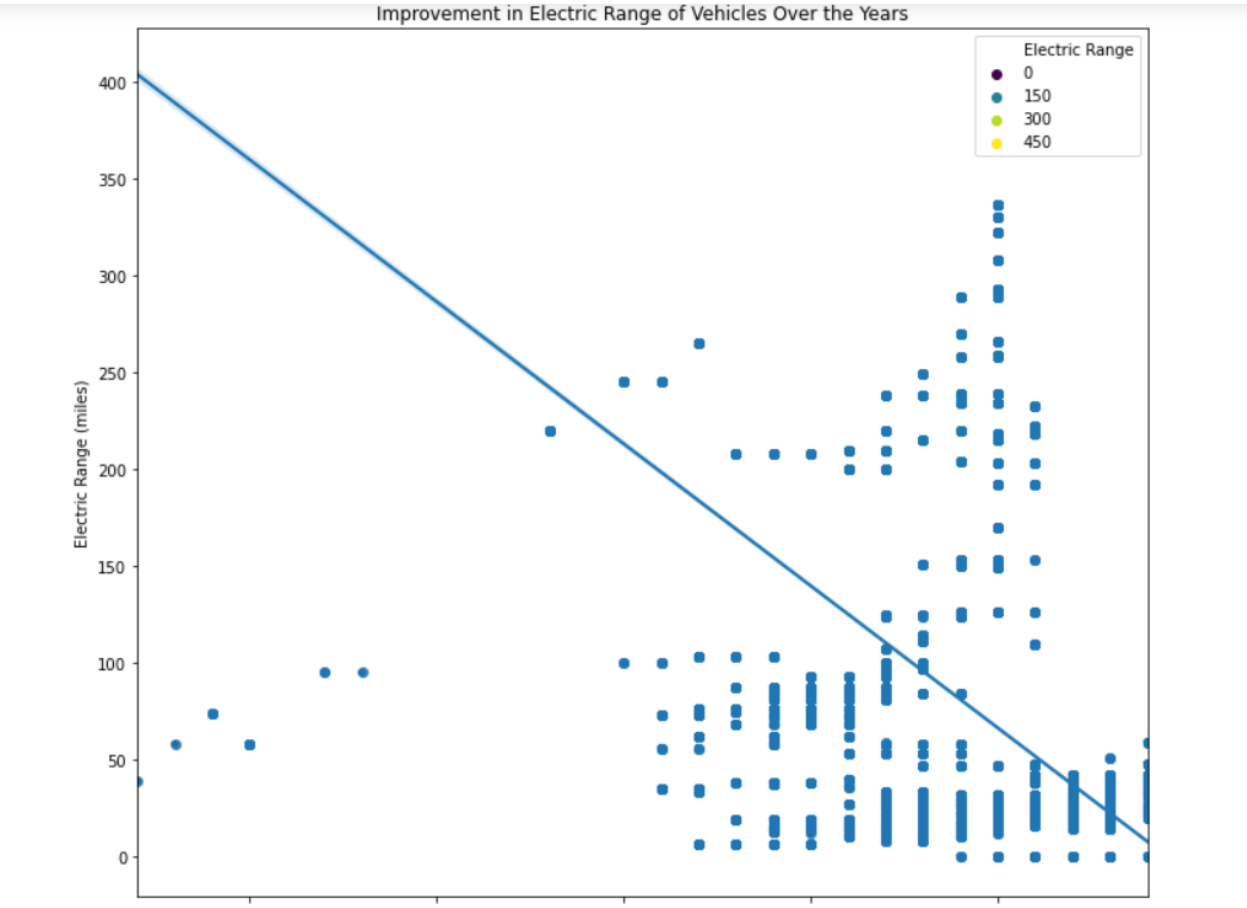
In [35]:
```
plt.figure(figsize=(10,9))
yearly_ev_counts.plot(kind='bar',stacked = True, x='Model Year',figsize=(14,8),width = 0.8)
plt.title('Comparison of BEVs and PHEVs Popularity Over Years')
plt.xlabel('Model Year')
plt.ylabel('Number of Vehicles')
plt.xticks(rotation = 45)
plt.tight_layout()
plt.show()
```



Conclusion: The comparison between Battery Electric Vehicles (BEVs) and Plug-in Hybrid Electric Vehicles (PHEVs) over the years highlights a clear trend towards **BEVs gaining popularity particularly in year 2023.**

3. Improvement in Electric Range of Vehicles Over the Years

In [40]:
```
# Improvement of Electric Range of Vehicles over the years
plt.figure(figsize=(10,9))
sns.scatterplot(data = df, x='Model Year', y= 'Electric Range',hue ='Electric Range', palette ='viridis')
sns.regplot(data = df, x='Model Year', y= 'Electric Range')
plt.title('Improvement in Electric Range of Vehicles Over the Years')
plt.xlabel('Model Year')
plt.ylabel('Electric Range (miles)')
plt.xticks(rotation = 45)
plt.tight_layout()
plt.show()
```



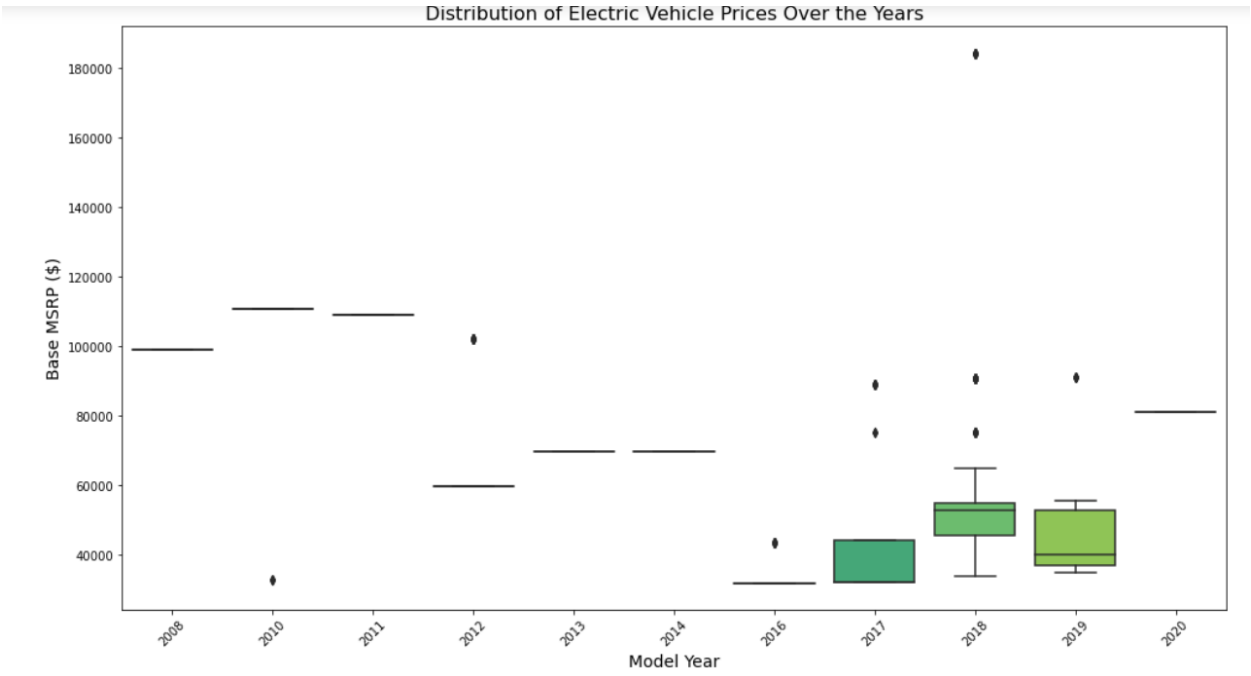
Conclusion: The scatterplot along with regression line, reveals the **significant improvement in electric range over the years**, showcasing a clear upward trend in electric range.

4. Distribution of Electric Vehicle Prices Over the Years

```
In [45]: # Distribution of Electric Vehicles Prices over the years

         filtered_df = df1[(df1['Base MSRP'] >0) & (df1['Base MSRP']<200000)]
```

In [46]:
```
plt.figure(figsize=(14, 8))
sns.boxplot(data=filtered_df, x='Model Year', y='Base MSRP', palette="viridis")
plt.title('Distribution of Electric Vehicle Prices Over the Years', fontsize=16)
plt.xlabel('Model Year', fontsize=14)
plt.ylabel('Base MSRP ($)', fontsize=14)
plt.xticks(rotation=45)
plt.tight_layout()
plt.show()
```



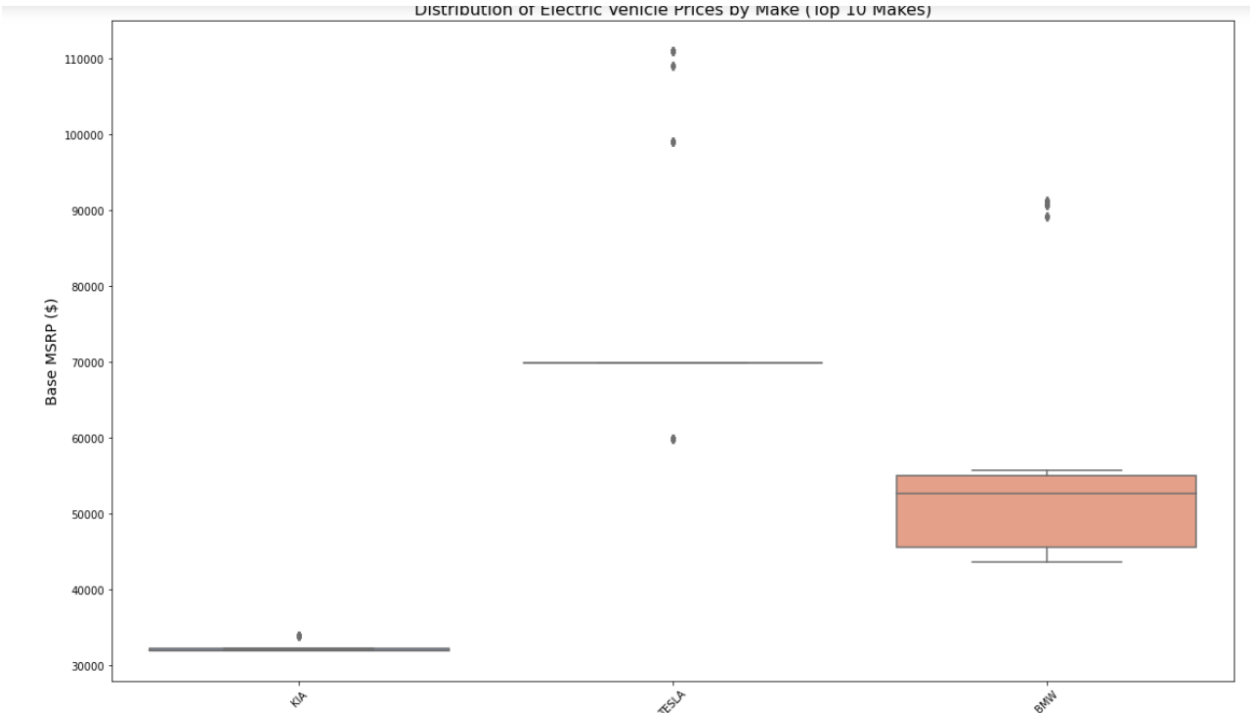
Conclusion: The visualization reveals a increase in the median price of electric vehicles over the years. In **2008 to 2011 the prices where very high** compare to prices now.

5. Distribution of Electric Vehicle Prices by Top3 Make

In [96]:
```
# Distribution of Electric Vehicles Prices by top 3 make

top_makes = df1['Make'].value_counts()
top_makes_3 = top_makes.head(3).index
#top_makes = filtered_df['Make'].value_counts().nlargest(3).index
filtered_top_makes_df = filtered_df[filtered_df['Make'].isin(top_makes_10)]
```

```
In [76]: plt.figure(figsize=(16, 10))
         sns.boxplot(data=filtered_top_makes_df, x='Make', y='Base MSRP', palette="coolwarm")
         plt.title('Distribution of Electric Vehicle Prices by Make (Top 10 Makes)', fontsize=16)
         plt.xlabel('Make', fontsize=14)
         plt.ylabel('Base MSRP ($)', fontsize=14)
         plt.xticks(rotation=45)
         plt.tight_layout()
         plt.show()
```



Conclusion: The boxplot reveals a significant variation in the Base MSRP among the top 3 EV makes, **BMW** as it is very popular has price range between 80000 to 180000. **Tesla** has the second highest price.

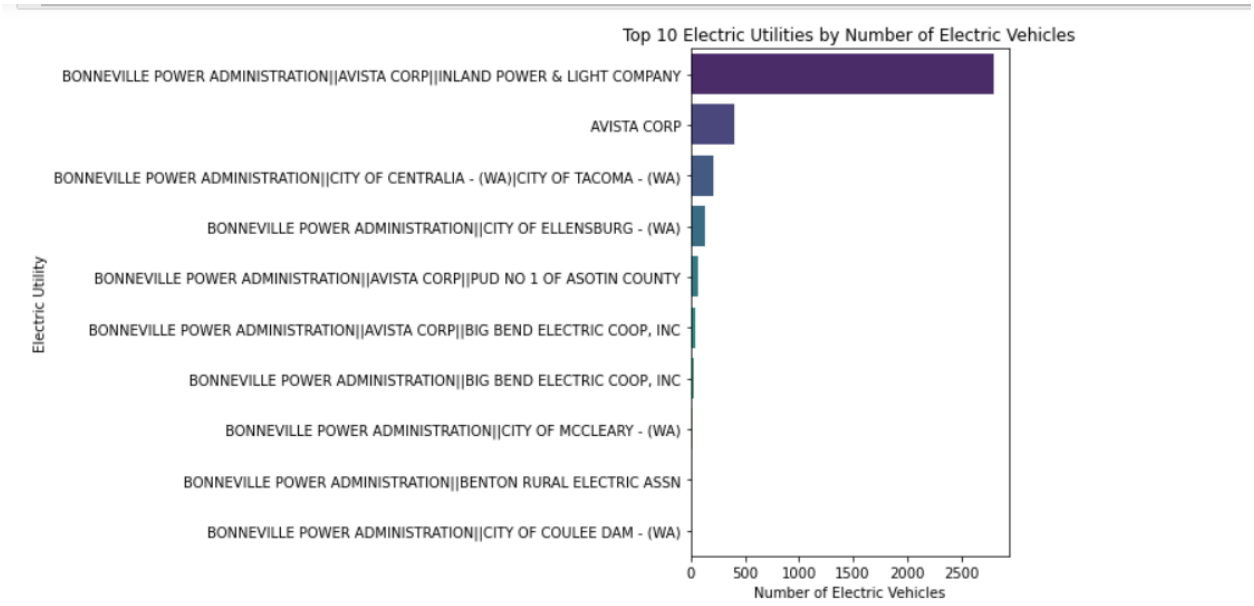
6. Top 10 Electric Utilities by Number of Electric Vehicles

```
In [78]: # Top 10 Electric utilities by number of electric vehicles

         utility_counts = df.groupby('Electric Utility')['DOL Vehicle ID'].count().reset_index().head(10).sort_values(by = 'DOL Vehicle ID
```

```
In [81]: plt.figure(figsize=(10, 6))
         sns.barplot(data=utility_counts, x='DOL Vehicle ID', y='Electric Utility', palette='viridis', order=utility_counts['Electric Util

         plt.title('Top 10 Electric Utilities by Number of Electric Vehicles')
         plt.xlabel('Number of Electric Vehicles')
         plt.ylabel('Electric Utility')
         plt.tight_layout()
         plt.show()
```



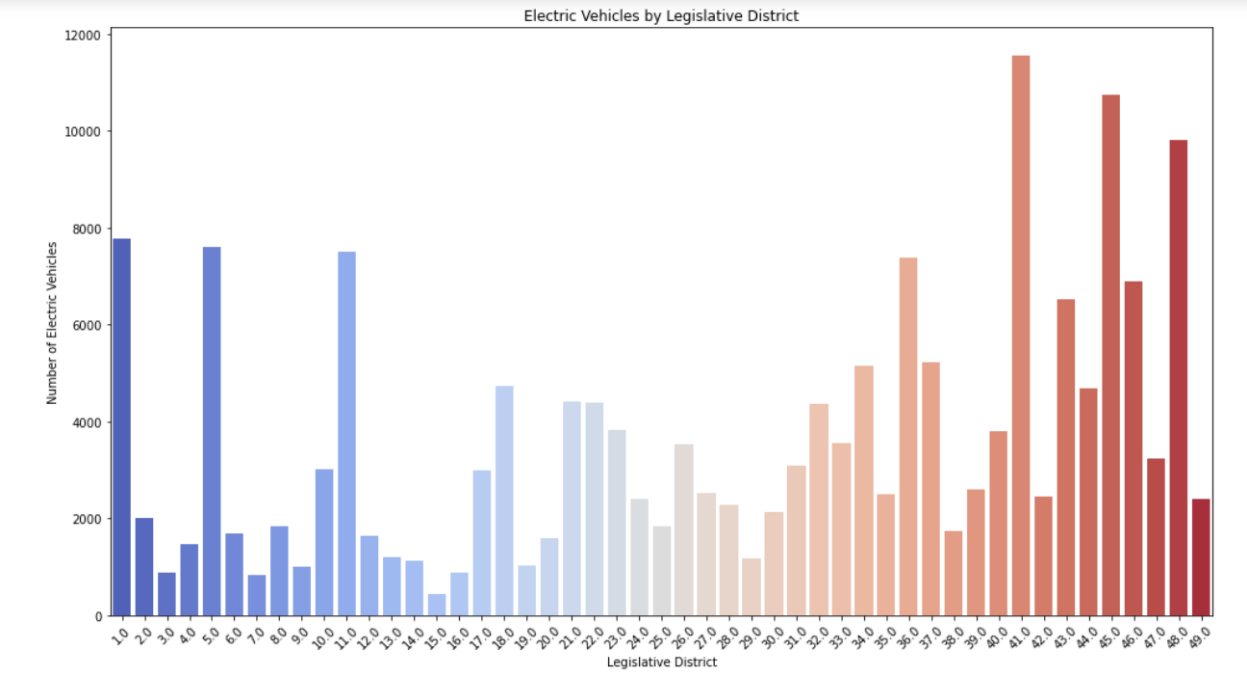
Conclusion: The bar chart shows the electric utilities by number of vehicles. **Puget sound energy inc.** has the highest number of electric vehicles

7. Electric Vehicle by Legislative District

```
In [82]: # Electric Vehicle by Legislative District

         district_counts = df.groupby('Legislative District')['DOL Vehicle ID'].count().reset_index().sort_values(by='DOL Vehicle ID', asc
```

```
In [84]: plt.figure(figsize=(14, 8))
         sns.barplot(x='Legislative District', y='DOL Vehicle ID', data=district_counts,
                     palette='coolwarm')
         plt.title('Electric Vehicles by Legislative District')
         plt.xlabel('Legislative District')
         plt.ylabel('Number of Electric Vehicles')
         plt.xticks(rotation=45)
         plt.tight_layout()
         plt.show()
```



Conclusion: The visualization highlights the disparity in electric vehicle (EV) adoption across legislative districts, with Districts **41, 45, and 48 leading by a significant margin.**