Data Analysis on Electric Vehicle

Importing Necessary Libraries

In [2]:
```
import numpy as np
import pandas as pd
from matplotlib import pyplot as plt
import seaborn as sns
import plotly.express as px
```

Reading DataFrame

In [2]:
```
df = pd.read_csv("dataset.csv")
```

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

Out[3]:

	VIN (1-10)	County	City	State	Postal Code	Model Year	Make	Model	Electric Vehicle Type	Clean Alternative Fuel Vehicle (CAFV) Eligibility	Electric Range	
0	JTMEB3FV6N	Monroe	Key West	FL	33040	2022	TOYOTA	RAV4 PRIME	Plug-in Hybrid Electric Vehicle (PHEV)	Clean Alternative Fuel Vehicle Eligible	42	
1	1G1RD6E45D	Clark	Laughlin	NV	89029	2013	CHEVROLET	VOLT	Plug-in Hybrid Electric Vehicle (PHEV)	Clean Alternative Fuel Vehicle Eligible	38	
2	JN1AZ0CP8B	Yakima	Yakima	WA	98901	2011	NISSAN	LEAF	Battery Electric Vehicle (BEV)	Clean Alternative Fuel Vehicle Eligible	73	
3	1G1FW6S08H	Skagit	Concrete	WA	98237	2017	CHEVROLET	BOLT EV	Battery Electric Vehicle (BEV)	Clean Alternative Fuel Vehicle Eligible	238	
4	3FA6P0SU1K	Snohomish	Everett	WA	98201	2019	FORD	FUSION	Plug-in Hybrid Electric Vehicle (PHEV)	Not eligible due to low battery range	26	

In [5]:
```
df.shape
```

Out[5]:
```
(112634, 17)
```

In [6]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 112634 entries, 0 to 112633
```

```
Data columns (total 17 columns):
 #   Column                                             Non-Null Count   Dtype
---  ------                                             --------------   -----
 0   VIN (1-10)                                         112634 non-null  object
 1   County                                             112634 non-null  object
 2   City                                               112634 non-null  object
 3   State                                              112634 non-null  object
 4   Postal Code                                        112634 non-null  int64
 5   Model Year                                         112634 non-null  int64
 6   Make                                               112634 non-null  object
 7   Model                                              112614 non-null  object
 8   Electric Vehicle Type                              112634 non-null  object
 9   Clean Alternative Fuel Vehicle (CAFV) Eligibility  112634 non-null  object
 10  Electric Range                                     112634 non-null  int64
 11  Base MSRP                                          112634 non-null  int64
 12  Legislative District                               112348 non-null  float64
 13  DOL Vehicle ID                                     112634 non-null  int64
 14  Vehicle Location                                   112610 non-null  object
 15  Electric Utility                                   112191 non-null  object
 16  2020 Census Tract                                  112634 non-null  int64
dtypes: float64(1), int64(6), object(10)
memory usage: 14.6+ MB
```

In [7]:
```
df.describe()
```

Out[7]:

	Postal Code	Model Year	Electric Range	Base MSRP	Legislative District	DOL Vehicle ID	2020 Census Tract
count	112634.000000	112634.000000	112634.000000	112634.000000	112348.000000	1.126340e+05	1.126340e+05
mean	98156.226850	2019.003365	87.812987	1793.439681	29.805604	1.994567e+08	5.296650e+10
std	2648.733064	2.892364	102.334216	10783.753486	14.700545	9.398427e+07	1.699104e+09
min	1730.000000	1997.000000	0.000000	0.000000	1.000000	4.777000e+03	1.101001e+09
25%	98052.000000	2017.000000	0.000000	0.000000	18.000000	1.484142e+08	5.303301e+10
50%	98119.000000	2020.000000	32.000000	0.000000	34.000000	1.923896e+08	5.303303e+10
75%	98370.000000	2022.000000	208.000000	0.000000	43.000000	2.191899e+08	5.305307e+10
max	99701.000000	2023.000000	337.000000	845000.000000	49.000000	4.792548e+08	5.603300e+10

Data Cleaning

In [11]:
```
df.isna().sum()
```

Out[11]:
```
VIN (1-10)                                             0
County                                                 0
City                                                   0
State                                                  0
Postal Code                                            0
Model Year                                             0
Make                                                   0
Model                                                 20
Electric Vehicle Type                                  0
Clean Alternative Fuel Vehicle (CAFV) Eligibility      0
Electric Range                                         0
Base MSRP                                              0
Legislative District                                 286
DOL Vehicle ID                                         0
Vehicle Location                                      24
Electric Utility                                     443
```

```
2020 Census Tract                                  0
dtype: int64
```

Checking for Duplicated Values

In [12]:
```
df.duplicated().sum()
```

Out[12]:
```
0
```

In [8]:
```
df["VIN (1-10)"].value_counts()
```

Out[8]:
```
VIN (1-10)
5YJYGDEE9M    472
5YJYGDEE0M    465
5YJYGDEE8M    448
5YJYGDEE7M    448
5YJYGDEE2M    437
             ...
WA1LAAGE9M      1
5UXKT0C50H      1
5YJYGAED3M      1
WDC0G5DBXL      1
YV4ED3GM0P      1
Name: count, Length: 7548, dtype: int64
```

In [14]:
```
df["County"].value_counts()
```

Out[14]:
```
County
King          59000
Snohomish     12434
Pierce         8535
Clark          6689
Thurston       4126
              ...
Pinal             1
Elmore            1
Portsmouth        1
Kings             1
Kootenai          1
Name: count, Length: 165, dtype: int64
```

In [15]:
```
df["City"].value_counts()
```

Out[15]:
```
City
Seattle         20305
Bellevue         5921
Redmond          4201
Vancouver        4013
Kirkland         3598
                ...
Hartline            1
Gaithersburg        1
El Paso             1
Klickitat           1
Worley              1
Name: count, Length: 629, dtype: int64
```

In [16]:
```
df["City"].unique()
```

Out[16]:
```
array(['Key West', 'Laughlin', 'Yakima', 'Concrete', 'Everett', 'Bothell',
       'Mukilteo', 'Clinton', 'Anacortes', 'Lacey', 'Moses Lake',
       'Mascoutah', 'Rochester', 'Burlington', 'Kapowsin', 'Marysville',
       'Lynnwood', 'Greenfield Center', 'Edmonds', 'Nine Mile Falls',
       'Olympia', 'Seattle', 'Auburn', 'Langley', 'Snohomish',
       'Bremerton', 'Newport News', 'Altus', 'Pullman', 'Highland Park',
```

'Spokane', 'Suquamish', 'Monroe', 'Sequim', 'Keyport', 'Gurnee',
'Maple Valley', 'Kent', 'Lake Forest Park', 'Poulsbo', 'Redmond',
'Issaquah', 'Longview', 'Tacoma', 'Ellensburg', 'Burien',
'Gig Harbor', 'South Hill', 'Sammamish', 'Westport', 'Vancouver',
'Airway Heights', 'Mercer Island', 'Stanwood', 'Tumwater',
'Bainbridge Island', 'Entiat', 'Lakewood', 'Lake Tapps',
'Bellevue', 'Kirkland', 'Newcastle', 'Port Orchard', 'Bellingham',
'Richland', 'Camano Island', 'Wenatchee', 'Lake Stevens', 'Roy',
'Des Moines', 'Renton', 'Camas', 'Kennewick', 'Battle Ground',
'Bonney Lake', 'Walla Walla', 'North Bend', 'Mount Vernon',
'Woodland', 'Woodinville', 'Allyn', 'Brier', 'Snoqualmie',
'Fall City', 'Puyallup', 'Friday Harbor', 'Point Roberts',
'Dupont', 'Castle Rock', 'Blaine', 'Morton', 'Port Townsend',
'Roslyn', 'Kenmore', 'Covington', 'Federal Way', 'Silverdale',
'Medina', 'Shoreline', 'Enumclaw', 'Orondo', 'Grandview',
'Mill Creek', 'Zillah', 'Edgewood', 'Vashon', 'White Salmon',
'Normandy Park', 'Fircrest', 'East Wenatchee', 'Peshastin',
'Grapeview', 'Steilacoom', 'Sumner', 'Junction City', 'Greenacres',
'Shelton', 'Chehalis', 'Pacific Beach', 'Everson', 'Black Diamond',
'North Bonneville', 'Coupeville', 'Seabeck', 'Arlington',
'Alexandria', 'Palouse', 'Bow', 'Lakebay', 'University Place',
'Clyde Hill', 'Cle Elum', 'Yacolt', 'Oak Harbor', 'Goldendale',
'Port Hadlock', 'Acme', 'Ritzville', 'Union', 'Orting', 'Tahuya',
'Fox Island', 'Moxee', 'Port Angeles', 'Spanaway', 'Lopez Island',
'Hunts Point', 'Leavenworth', 'Seatac', 'Stevenson', 'Pasco',
'Yelm', 'Tonasket', 'Liberty Lake', 'Hansville', 'Eastsound',
'Nordland', 'Touchet', 'Spokane Valley', 'Tukwila', 'Selah',
'Fife', 'Lynden', 'Aberdeen', 'Anderson Island', 'Orcas Is',
'Kingston', 'Randle', 'Sedro-Woolley', 'Carnation', 'Belfair',
'Cheney', 'Elma', 'Olalla', 'Granite Falls', 'Ephrata', 'Preston',
'Ridgefield', 'Mccleary', 'Ferndale', 'Mountlake Terrace',
'Freeland', 'Sonoma', 'Yarrow Point', 'Rainier', 'Sunnyside',
'Salkum', 'Colville', 'Duvall', 'Otis Orchards', 'Twisp',
'Eatonville', 'Chattaroy', 'Ocean Shores', 'Washougal',
'Port Ludlow', 'Benton City', 'Clarkston', 'Ravensdale', 'Kelso',
'Curlew', 'Deming', 'Prosser', 'Milton', 'Artondale', 'Hoodsport',
'West Richland', 'Parkland', 'Chelan', 'Graham', 'Raymond',
'Brush Prairie', 'Rock Island', 'La Conner', 'St John', 'Mead',
'Hoquiam', 'Deer Park', 'Electric City', 'Chimacum', 'Burbank',
'Quincy', 'Omaha', 'La Center', 'Ronald', 'Long Beach', 'Valley',
'Beaux Arts', 'Kalama', 'Indianola', 'Winthrop', 'Wildomar',
'Aliso Viejo', 'Woodway', 'Buckley', 'Montesano', 'Las Vegas',
'Dayton', 'Vaughn', 'Onalaska', 'Medical Lake', 'Nooksack',
'Centralia', 'Sultan', 'Trout Lake', 'Seaview', 'Carson',
'Colbert', 'Lummi Island', 'Newman Lake', 'Cathlamet', 'Veradale',
'Valleyford', 'Cashmere', 'Ariel', 'Cosmopolis', 'Bz Corner',
'Ilwaco', 'Oakville', 'Algona', 'Silverlake', 'Lopez Is',
'Winlock', 'Greenbank', 'Tenino', 'Royal City', 'Tulalip',
'Fort Leavenworth', 'Custer', 'Moraga', 'College Place',
'Underwood', 'Amboy', 'Bingen', 'Ryderwood', 'Clearlake', 'Naches',
'Surfside', 'Olga', 'Ocean Park', 'Othello', 'Rosalia',
'Snoqualmie Pass', 'Timnath', 'Republic', 'Washington',
'Keedysville', 'Atoka', 'San Diego', 'Sumter', 'Upper Marlboro',
'Madison', 'Lincoln City', 'Grand Coulee', 'Trinidad', 'Chewelah',
'Packwood', 'Thorp', 'Frederick', 'Malaga', 'Lind',
'Joint Base Lewis Mcchord', 'Granger', 'Wilbur', 'Toledo',
'Pacific', 'Toppenish', 'Eltopia', 'Sekiu', 'Sedro Woolley',
'Garfield', 'Lincoln', 'Mcallen', 'Newport', 'Harrington',
'San Antonio', 'Ethel', 'Pomeroy', 'Longbranch', 'Connell',
'Brinnon', 'Skykomish', 'Reardan', 'Maple Falls', 'Rapid City',
'Coulee City', 'Dallesport', 'Vantage', 'Oroville', 'Manson',
'Honolulu', 'Omak', 'Bridgeport Bar', 'Mesa', 'Odenton',
'Waterville', 'Chinook', 'Gold Bar', 'Soap Lake', 'Nahcotta',
'Tieton', 'Silver Spring', 'Warner Robins', 'Mattawa', 'Addy',
'Ruston', 'Loon Lake', 'Charleston Afb', 'Forks', 'Wapato',
'Naselle', 'Quilcene', 'Asotin', 'Monterey', 'Easton',

```
       'Fairchild Air Force Base', 'Ridgecrest', 'Skamokawa', 'Lilliwaup',
       'Napa', 'Aldie', 'Marlin', 'Warden', 'Biloxi', 'Seven Bays',
       'Chula Vista', 'Little Rock', 'Fayetteville', 'Kettle Falls',
       'South Bend', 'Rayville', 'Okanogan', 'Mansfield', 'Pateros',
       'Sumas', 'Salt Lake City', 'McCleary', 'North Las Vegas', 'Cusick',
       'Vacaville', 'Fort Campbell', 'Wexford', 'Ashford', 'Elk',
       'Carbonado', 'Rockford', 'Lyle', 'Latah', 'Westminster', 'Carlton',
       'Darrington', 'West Linn', 'Mossyrock', 'Dover', 'Tumtum',
       'Arnold', 'Tavares', 'Houston', 'Ventura', 'Riverside',
       'North Cove', 'Bay Center', 'Brewster', 'Springdale', 'Cougar',
       'Endicott', 'Inchelium', 'Wilkeson', 'Cincinnati', 'Salem',
       'Roseville', 'Chesapeake Beach', 'Frances', 'Colfax', 'White Swan',
       'Grayland', 'Rice', 'Sheridan', 'Neah Bay', 'Lemoore',
       'Montgomery', 'Colorado Springs', 'Davenport', 'Portsmouth',
       'Lancaster', 'Coulee Dam', 'Union Gap', 'Menifee', 'Shaw Island',
       'Mountain Home Afb', 'Marblemount', 'Santa Clara', 'Baring',
       'Spangle', 'Glacier', 'Maricopa', 'Carmel By The Sea',
       'Deer Meadows', 'Silver Creek', 'Goldsboro', 'Menlo', 'Tokeland',
       'Berkeley', 'Phoenix', 'Stafford', 'Roosevelt', 'Chandler',
       'Wahkiacus', 'Lompoc', 'Alhambra', 'Buena Park', 'Snowden',
       'Walla Walla Co', 'Outlook', 'Vader', 'Fairbanks', 'Cupertino',
       'Kittitas', 'Mica', 'Indian Wells', 'Mazama', 'Hunters',
       'Camarillo', 'Belle Chasse', 'Evans', 'Beaver', 'Grays River',
       'West Valley City', 'Oceanside', 'Odessa', 'Usk', 'Roswell',
       'Gambrills', 'Oysterville', 'Potomac', 'Mineral', 'Amanda Park',
       'Toutle', 'Curtis', 'Cinebar', 'Hartline', 'Waitsburg',
       'Gaithersburg', 'Husum', 'El Paso', 'Klickitat', 'Elkton',
       'Edwall', 'Sprague', 'West Palm Beach', 'Tekoa', 'Coronado',
       'Pe Ell', 'Methow', 'Danville', 'Annapolis', 'Murdock',
       'Mechanicsburg', 'Ford', 'Dickinson', 'Virginia Beach', 'Benicia',
       'Moclips', 'Suffolk', 'Holden Village', 'Bumpass', 'Lithia',
       'Felts Mills', 'Little Elm', 'Andrews Air Force Base', 'Lyman',
       'Harker Heights', 'Pittsburg', 'Norristown', 'Mcchord Afb',
       'Norfolk', 'Valparaiso', 'Conyers', 'Skokie', 'Glenwood',
       'Chesapeake', 'Fpo', 'Hughesville', 'Belleville', 'Colton',
       'South Prairie', 'Clallam Bay', 'Longmont', 'Malott', 'Okatie',
       'Saint Louis', 'Lexington Park', 'Rockport', 'San Rafael',
       'Bucoda', 'Germantown', 'Smith Creek', 'Englewood', 'Lebam',
       'South Range', 'Tempe', 'Fort Bragg', 'Ewa Beach', 'Glenoma',
       'Cheyenne', 'Portland', 'Burke', 'Hawthorne', 'Copalis Beach',
       'Satsop', 'Palisades', 'Goodyear', 'Gardena', 'Southworth',
       'Raeford', 'Rosamond', 'Clayton', 'Quinault', 'Sarasota',
       'Santa Cruz', 'Jamaica', 'Wichita Falls', 'Maryhill', 'Yermo',
       'Vienna', 'Waldron', 'Clarksville', 'Goshen', 'Herndon',
       'Fruitland', 'Mccutcheon Field', 'South Cle Elum', 'Irvine',
       'Centerville', 'Fairfield', 'Lamont', 'Santa Rosa',
       'Southern Pines', 'Copalis Crossing', 'De Queen', 'Taholah',
       'Mountain View', 'Adairsville', 'Sacramento', 'Port Gamble',
       'Apple Valley', 'Rosburg', 'Stratford', 'Haddonfield',
       'Minneapolis', 'Chelmsford', 'Old Lyme', 'Platte City',
       'Hanscom Afb', 'Fort George G Meade', 'Bangor', 'Matlock',
       'Canoga Park', 'Jericho', 'Gifford', 'Santa Ana', 'Augusta',
       'San Clemente', 'Middletown', 'Prescott', 'San Mateo', 'Aurora',
       'Bedford', 'Carrolls', 'Fredericksburg', 'Waterford', 'Decatur',
       'Mililani', 'Kekaha', 'Medford', 'Edgewater', 'Slidell',
       'Pawcatuck', 'Groton', 'Richmond Hill', 'Mabton', 'Joint Base Mdl',
       'Uniontown', 'Palo Alto', 'North Conway', 'Summerville', 'Lansing',
       'Williston', 'Worley'], dtype=object)
```

In [17]:
```
df["State"].value_counts()
```

Out[17]:
```
State
WA    112348
CA        76
VA        36
MD        26
```

```
TX        14
CO         9
NV         8
GA         7
NC         7
CT         6
DC         6
FL         6
AZ         6
IL         6
SC         5
OR         5
NE         5
HI         4
UT         4
AR         4
NY         4
TN         3
KS         3
MO         3
PA         3
MA         3
LA         3
NJ         3
NH         2
OH         2
WY         2
ID         2
KY         1
RI         1
ME         1
MN         1
SD         1
WI         1
NM         1
AK         1
MS         1
AL         1
DE         1
OK         1
ND         1
Name: count, dtype: int64
```

In [19]:
```
df["Postal Code"].value_counts()
```

Out[19]:
```
Postal Code
98052    2916
98033    2059
98004    2001
98115    1880
98006    1852
         ...
21701       1
98621       1
84128       1
92051       1
83876       1
Name: count, Length: 773, dtype: int64
```

In [44]:
```
df["Model"].value_counts()
```

Out[44]:
```
Model
MODEL 3        23135
MODEL Y        17142
LEAF           12880
MODEL S         7377
```

```
BOLT EV          4910
                ...
745LE               2
S-10 PICKUP         1
SOLTERRA            1
918                 1
FLYING SPUR         1
Name: count, Length: 114, dtype: int64
```

In [141…
```
df["Make"].value_counts()
```

Out[141]:
```
Make
TESLA             51883
NISSAN            12846
CHEVROLET         10140
FORD               5780
BMW                4660
KIA                4469
TOYOTA             4368
VOLKSWAGEN         2507
AUDI               2320
VOLVO              2276
CHRYSLER           1780
HYUNDAI            1407
JEEP               1143
RIVIAN              883
FIAT                820
PORSCHE             817
HONDA               788
MINI                631
MITSUBISHI          585
POLESTAR            557
MERCEDES-BENZ       503
SMART               271
JAGUAR              218
LINCOLN             167
CADILLAC            108
LUCID MOTORS         65
SUBARU               59
LAND ROVER           38
LEXUS                33
FISKER               19
GENESIS              18
AZURE DYNAMICS        7
TH!NK                 3
BENTLEY               3
Name: count, dtype: int64
```

Filling Null Values in Model Column with Mode of Make w.r.t Model

In [46]:
```
df["Model"].isna().sum()
```

Out[46]:
```
20
```

In [47]:
```
df[df["Model"].isna()]
```

Out[47]:

	VIN (1-10)	County	City	State	Postal Code	Model Year	Make	Model	Electric Vehicle Type	Clean Alternative Fuel Vehicle (CAFV) Eligibility	Electri Rang
13874	YV4ED3GM2P	King	Seattle	WA	98115	2023	VOLVO	NaN	Battery	Eligibility	

									Electric Vehicle (BEV)	unknown as battery range has not b...
30517	YV4ED3UL3P	King	Seattle	WA	98115	2023	VOLVO	NaN	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...
31936	YV4ED3GM4P	Clallam	Sequim	WA	98382	2023	VOLVO	NaN	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...
37517	YV4ED3UW2P	Snohomish	Edmonds	WA	98026	2023	VOLVO	NaN	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...
58071	YV4ED3UM4P	King	Renton	WA	98058	2023	VOLVO	NaN	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...
61626	YV4ED3GM5P	Pierce	Tacoma	WA	98465	2023	VOLVO	NaN	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...
63240	YV4ED3GMXP	King	Redmond	WA	98052	2023	VOLVO	NaN	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...
63380	YV4ED3GM7P	King	Seattle	WA	98122	2023	VOLVO	NaN	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...
63462	YV4ED3UW4P	King	Newcastle	WA	98059	2023	VOLVO	NaN	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...
78472	YV4ED3UM1P	King	Fall City	WA	98024	2023	VOLVO	NaN	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...
81302	YV4ED3UM5P	King	Redmond	WA	98052	2023	VOLVO	NaN	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...
84142	YV4ED3UM2P	King	North Bend	WA	98045	2023	VOLVO	NaN	Battery Electric	Eligibility unknown as battery

										Vehicle (BEV)	range has not b...	
86960	YV4ED3UM9P	King	Sammamish	WA	98075	2023	VOLVO	NaN	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...		
88687	YV4ED3GM5P	King	Maple Valley	WA	98038	2023	VOLVO	NaN	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...		
89882	YV4ED3UM5P	King	Bellevue	WA	98006	2023	VOLVO	NaN	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...		
93197	YV4ED3GM8P	Snohomish	Bothell	WA	98021	2023	VOLVO	NaN	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...		
103099	YV4ED3UW6P	Pierce	Milton	WA	98354	2023	VOLVO	NaN	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...		
103394	YV4ED3GM5P	King	Seattle	WA	98133	2023	VOLVO	NaN	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...		
108116	YV4ED3GL1P	King	Seattle	WA	98104	2023	VOLVO	NaN	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...		
112622	YV4ED3GM0P	King	Covington	WA	98042	2023	VOLVO	NaN	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...		

In [49]:
```
df[df["VIN (1-10)"]=="YV4ED3GM7P"]
```

Out[49]:

	VIN (1-10)	County	City	State	Postal Code	Model Year	Make	Model	Electric Vehicle Type	Clean Alternative Fuel Vehicle (CAFV) Eligibility	Electric Range	Base MSRP
63380	YV4ED3GM7P	King	Seattle	WA	98122	2023	VOLVO	NaN	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...	0	0

In [53]:
```
df.loc[(df["Make"]=="VOLVO")&(df["Model Year"]==2023)]
```

Out[53]:

	VIN (1-10)	County	City	State	Postal Code	Model Year	Make	Model	Electric Vehicle Type	Clean Alternative Fuel Vehicle (CAFV) Eligibility	Electri Rang
13874	YV4ED3GM2P	King	Seattle	WA	98115	2023	VOLVO	NaN	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...	
30517	YV4ED3UL3P	King	Seattle	WA	98115	2023	VOLVO	NaN	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...	
31936	YV4ED3GM4P	Clallam	Sequim	WA	98382	2023	VOLVO	NaN	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...	
37517	YV4ED3UW2P	Snohomish	Edmonds	WA	98026	2023	VOLVO	NaN	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...	
58071	YV4ED3UM4P	King	Renton	WA	98058	2023	VOLVO	NaN	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...	
61626	YV4ED3GM5P	Pierce	Tacoma	WA	98465	2023	VOLVO	NaN	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...	
63240	YV4ED3GMXP	King	Redmond	WA	98052	2023	VOLVO	NaN	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...	
63380	YV4ED3GM7P	King	Seattle	WA	98122	2023	VOLVO	NaN	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...	
63462	YV4ED3UW4P	King	Newcastle	WA	98059	2023	VOLVO	NaN	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...	
78472	YV4ED3UM1P	King	Fall City	WA	98024	2023	VOLVO	NaN	Battery Electric Vehicle (BEV)	Eligibility unknown as battery	

										range has not b...
81302	YV4ED3UM5P	King	Redmond	WA	98052	2023	VOLVO	NaN	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...
84142	YV4ED3UM2P	King	North Bend	WA	98045	2023	VOLVO	NaN	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...
86960	YV4ED3UM9P	King	Sammamish	WA	98075	2023	VOLVO	NaN	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...
87651	YV4ED3UK1P	King	Seattle	WA	98125	2023	VOLVO	XC40	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...
88687	YV4ED3GM5P	King	Maple Valley	WA	98038	2023	VOLVO	NaN	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...
89882	YV4ED3UM5P	King	Bellevue	WA	98006	2023	VOLVO	NaN	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...
93197	YV4ED3GM8P	Snohomish	Bothell	WA	98021	2023	VOLVO	NaN	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...
103099	YV4ED3UW6P	Pierce	Milton	WA	98354	2023	VOLVO	NaN	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...
103394	YV4ED3GM5P	King	Seattle	WA	98133	2023	VOLVO	NaN	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...
108116	YV4ED3GL1P	King	Seattle	WA	98104	2023	VOLVO	NaN	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...
112622	YV4ED3GM0P	King	Covington	WA	98042	2023	VOLVO	NaN	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...

In [55]:
```
df[df["Make"]=="VOLVO"].mode()
```

Out[55]:

	VIN (1-10)	County	City	State	Postal Code	Model Year	Make	Model	Electric Vehicle Type	Clean Alternative Fuel Vehicle (CAFV) Eligibility	Electric Range	Base MSRP
0	YV4ED3UR4M	King	Seattle	WA	98110.0	2022.0	VOLVO	XC90	Plug-in Hybrid Electric Vehicle (PHEV)	Not eligible due to low battery range	0.0	0.0
1	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
2	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
3	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
4	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
...	...	...	...	...	...	...	...	...	...	...	...	...
2283	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
2284	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
2285	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
2286	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
2287	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN

2288 rows × 17 columns

In [62]:
```
df["Model"] = df["Model"].apply(lambda x : df[df["Make"]=="VOLVO"].mode() if x is np.nan
```

In [64]:
```
df["Model"].isna().sum()
```

Out[64]:
```
0
```

Checking Null Values in Legislative District

In [65]:
```
df.head()
```

Out[65]:

	VIN (1-10)	County	City	State	Postal Code	Model Year	Make	Model	Electric Vehicle Type	Clean Alternative Fuel Vehicle (CAFV) Eligibility	Electric Range	M
0	JTMEB3FV6N	Monroe	Key West	FL	33040	2022	TOYOTA	RAV4 PRIME	Plug-in Hybrid Electric Vehicle (PHEV)	Clean Alternative Fuel Vehicle Eligible	42	
1	1G1RD6E45D	Clark	Laughlin	NV	89029	2013	CHEVROLET	VOLT	Plug-in	Clean	38	

									Hybrid Electric Vehicle (PHEV)	Alternative Fuel Vehicle Eligible	
2	JN1AZ0CP8B	Yakima	Yakima	WA	98901	2011	NISSAN	LEAF	Battery Electric Vehicle (BEV)	Clean Alternative Fuel Vehicle Eligible	73
3	1G1FW6S08H	Skagit	Concrete	WA	98237	2017	CHEVROLET	BOLT EV	Battery Electric Vehicle (BEV)	Clean Alternative Fuel Vehicle Eligible	238
4	3FA6P0SU1K	Snohomish	Everett	WA	98201	2019	FORD	FUSION	Plug-in Hybrid Electric Vehicle (PHEV)	Not eligible due to low battery range	26

In [66]:
```
df["Legislative District"].isna().sum()
```

Out[66]:
```
286
```

In [67]:
```
df["Legislative District"].value_counts()
```

Out[67]:
```
Legislative District
41.0    7605
45.0    7112
48.0    6462
36.0    5251
46.0    4723
1.0     4715
5.0     4694
43.0    4621
37.0    3556
34.0    3478
18.0    3024
22.0    2782
32.0    2709
11.0    2707
44.0    2670
40.0    2633
23.0    2626
21.0    2617
26.0    2267
33.0    2112
10.0    2061
31.0    1912
17.0    1907
47.0    1876
24.0    1664
27.0    1654
42.0    1626
35.0    1620
39.0    1574
49.0    1573
28.0    1448
30.0    1268
2.0     1226
8.0     1157
38.0    1079
25.0    1049
6.0     1041
```

```
12.0    1004
20.0     973
4.0      845
13.0     748
14.0     720
29.0     692
19.0     672
16.0     611
9.0      606
3.0      557
7.0      544
15.0     277
Name: count, dtype: int64
```

In [70]:
```
df[df["State"]=="FL"]
```

Out[70]:

	VIN (1-10)	County	City	State	Postal Code	Model Year	Make	Model	Electric Vehicle Type	Clean Alternative Fuel Vehicle (CAFV) Eligibility	Electri Range
0	JTMEB3FV6N	Monroe	Key West	FL	33040	2022	TOYOTA	RAV4 PRIME	Plug-in Hybrid Electric Vehicle (PHEV)	Clean Alternative Fuel Vehicle Eligible	42
24718	5YJ3E1EA6K	Lake	Tavares	FL	32778	2019	TESLA	MODEL 3	Battery Electric Vehicle (BEV)	Clean Alternative Fuel Vehicle Eligible	220
57355	5YJSA1E2XH	Palm Beach	West Palm Beach	FL	33415	2017	TESLA	MODEL S	Battery Electric Vehicle (BEV)	Clean Alternative Fuel Vehicle Eligible	210
61797	JTMEB3FV3N	Hillsborough	Lithia	FL	33547	2022	TOYOTA	RAV4 PRIME	Plug-in Hybrid Electric Vehicle (PHEV)	Clean Alternative Fuel Vehicle Eligible	42
64101	3FA6P0PU2F	Okaloosa	Valparaiso	FL	32580	2015	FORD	FUSION	Plug-in Hybrid Electric Vehicle (PHEV)	Not eligible due to low battery range	19
80896	5YJ3E1EA4K	Sarasota	Sarasota	FL	34242	2019	TESLA	MODEL 3	Battery Electric Vehicle (BEV)	Clean Alternative Fuel Vehicle Eligible	220

- As Legislative District is related to District Code and from above it is seen than Legislative District code for FL is all Null values so dropping them

In [72]:
```
df.dropna(subset="Legislative District",axis=0,inplace=True)
```

In [73]:
```
df["Legislative District"].isna().sum()
```

```
0
```

Out[73]:

Checking Null Values in Vehicle Location

In [75]:
```
df["Vehicle Location"].isna().sum()
```

Out[75]:
```
19
```

In [76]:
```
df.dropna(subset="Vehicle Location",axis=0,inplace=True)
```

In [77]:
```
df["Vehicle Location"].isna().sum()
```

Out[77]:
```
0
```

Checking Null Values in Electric Utility

In [78]:
```
df["Electric Utility"].isna().sum()
```

Out[78]:
```
157
```

In [20]:
```
df["Electric Utility"].value_counts()
```

Out[20]:
```
Electric Utility
PUGET SOUND ENERGY INC||CITY OF TACOMA - (WA)
    40247
PUGET SOUND ENERGY INC
    22172
CITY OF SEATTLE - (WA)|CITY OF TACOMA - (WA)
    21447
BONNEVILLE POWER ADMINISTRATION||PUD NO 1 OF CLARK COUNTY - (WA)
     6522
BONNEVILLE POWER ADMINISTRATION||CITY OF TACOMA - (WA)||PENINSULA LIGHT COMPANY
     5053

    ...
BONNEVILLE POWER ADMINISTRATION||PENINSULA LIGHT COMPANY
        1
BONNEVILLE POWER ADMINISTRATION||PUD NO 1 OF ASOTIN COUNTY
        1
CITY OF SEATTLE - (WA)
        1
BONNEVILLE POWER ADMINISTRATION||NESPELEM VALLEY ELEC COOP, INC
        1
BONNEVILLE POWER ADMINISTRATION||PUD NO 1 OF CLALLAM COUNTY|PUD NO 1 OF JEFFERSON COUNTY
        1
Name: count, Length: 73, dtype: int64
```

In [33]:
```
df1 = df[["Make","Model","Electric Vehicle Type","Electric Utility"]]
df1
```

Out[33]:

	Make	Model	Electric Vehicle Type	Electric Utility
0	TOYOTA	RAV4 PRIME	Plug-in Hybrid Electric Vehicle (PHEV)	NaN
1	CHEVROLET	VOLT	Plug-in Hybrid Electric Vehicle (PHEV)	NaN
2	NISSAN	LEAF	Battery Electric Vehicle (BEV)	PACIFICORP
3	CHEVROLET	BOLT EV	Battery Electric Vehicle (BEV)	PUGET SOUND ENERGY INC

4	FORD	FUSION	Plug-in Hybrid Electric Vehicle (PHEV)	PUGET SOUND ENERGY INC
...	...	...	...	...
112629	TESLA	MODEL Y	Battery Electric Vehicle (BEV)	PUGET SOUND ENERGY INC||CITY OF TACOMA - (WA)
112630	NISSAN	LEAF	Battery Electric Vehicle (BEV)	BONNEVILLE POWER ADMINISTRATION||ORCAS POWER &...
112631	FORD	ESCAPE	Plug-in Hybrid Electric Vehicle (PHEV)	PUGET SOUND ENERGY INC||CITY OF TACOMA - (WA)
112632	KIA	NIRO	Plug-in Hybrid Electric Vehicle (PHEV)	PUGET SOUND ENERGY INC||CITY OF TACOMA - (WA)
112633	VOLVO	XC90	Plug-in Hybrid Electric Vehicle (PHEV)	PUGET SOUND ENERGY INC||CITY OF TACOMA - (WA)

112634 rows × 4 columns

In [41]:
```
df.loc[df["State"]=="FL"]
```

Out[41]:

	VIN (1-10)	County	City	State	Postal Code	Model Year	Make	Model	Electric Vehicle Type	Clean Alternative Fuel Vehicle (CAFV) Eligibility	Electri Range
0	JTMEB3FV6N	Monroe	Key West	FL	33040	2022	TOYOTA	RAV4 PRIME	Plug-in Hybrid Electric Vehicle (PHEV)	Clean Alternative Fuel Vehicle Eligible	42
24718	5YJ3E1EA6K	Lake	Tavares	FL	32778	2019	TESLA	MODEL 3	Battery Electric Vehicle (BEV)	Clean Alternative Fuel Vehicle Eligible	220
57355	5YJSA1E2XH	Palm Beach	West Palm Beach	FL	33415	2017	TESLA	MODEL S	Battery Electric Vehicle (BEV)	Clean Alternative Fuel Vehicle Eligible	210
61797	JTMEB3FV3N	Hillsborough	Lithia	FL	33547	2022	TOYOTA	RAV4 PRIME	Plug-in Hybrid Electric Vehicle (PHEV)	Clean Alternative Fuel Vehicle Eligible	42
64101	3FA6P0PU2F	Okaloosa	Valparaiso	FL	32580	2015	FORD	FUSION	Plug-in Hybrid Electric Vehicle (PHEV)	Not eligible due to low battery range	19
80896	5YJ3E1EA4K	Sarasota	Sarasota	FL	34242	2019	TESLA	MODEL 3	Battery Electric Vehicle (BEV)	Clean Alternative Fuel Vehicle Eligible	220

In [42]:
```
df.loc[df["State"]=="NY"]
```

Out[42]:

	VIN (1-10)	County	City	State	Postal Code	Model Year	Make	Model	Electric Vehicle Type	Clean Alternative Fuel Vehicle (CAFV) Eligibility	Electric Range
19	5YJXCAE28G	Saratoga	Greenfield Center	NY	12833	2016	TESLA	MODEL X	Battery Electric Vehicle (BEV)	Clean Alternative Fuel Vehicle Eligible	200
61925	1FADP5CU3F	Jefferson	Felts Mills	NY	13638	2015	FORD	C-MAX	Plug-in Hybrid Electric Vehicle (PHEV)	Not eligible due to low battery range	19
82396	5YJ3E1EB4M	Queens	Jamaica	NY	11436	2021	TESLA	MODEL 3	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...	0
100232	1N4BZ0CP1H	Nassau	Jericho	NY	11753	2017	NISSAN	LEAF	Battery Electric Vehicle (BEV)	Clean Alternative Fuel Vehicle Eligible	107

In [40]:
```
df.loc[df["County"]=="Monroe"]
```

Out[40]:

	VIN (1-10)	County	City	State	Postal Code	Model Year	Make	Model	Electric Vehicle Type	Clean Alternative Fuel Vehicle (CAFV) Eligibility	Electric Range	Base MSRP	Legi... D
0	JTMEB3FV6N	Monroe	Key West	FL	33040	2022	TOYOTA	RAV4 PRIME	Plug-in Hybrid Electric Vehicle (PHEV)	Clean Alternative Fuel Vehicle Eligible	42	0	

In [25]:
```
df.loc[df["Electric Utility"].isna()]
```

Out[25]:

	VIN (1-10)	County	City	State	Postal Code	Model Year	Make	Model	Electric Vehicle Type	Cle... Alternat... F... Vehi... (CA... Eligibi...
0	JTMEB3FV6N	Monroe	Key West	FL	33040	2022	TOYOTA	RAV4 PRIME	Plug-in Hybrid Electric Vehicle (PHEV)	Cle... Alternat... Fuel Veh... Eligi...
1	1G1RD6E45D	Clark	Laughlin	NV	89029	2013	CHEVROLET	VOLT	Plug-in Hybrid Electric Vehicle (PHEV)	Cle... Alternat... Fuel Veh... Eligi...

12	3C3CFFGE3G	St. Clair	Mascoutah	IL	62258	2016	FIAT	500	Battery Electric Vehicle (BEV)	Cle Alternat Fuel Veh Eligi
19	5YJXCAE28G	Saratoga	Greenfield Center	NY	12833	2016	TESLA	MODEL X	Battery Electric Vehicle (BEV)	Cle Alternat Fuel Veh Eligi
21	1G1RD6S55H	Stevens	Nine Mile Falls	WA	99026	2017	CHEVROLET	VOLT	Plug-in Hybrid Electric Vehicle (PHEV)	Cle Alternat Fuel Veh Eligi
...	...	...	...	...	...	...	...	...	...	
112301	5YJ3E1EB9M	Dorchester	Summerville	SC	29483	2021	TESLA	MODEL 3	Battery Electric Vehicle (BEV)	Eligibi unkno as batt range not
112321	1N4BZ1CP7K	Thurston	Olympia	WA	98502	2019	NISSAN	LEAF	Battery Electric Vehicle (BEV)	Cle Alternat Fuel Veh Eligi
112394	5UXKT0C36H	Leavenworth	Lansing	KS	66043	2017	BMW	X5	Plug-in Hybrid Electric Vehicle (PHEV)	Not eligi due to batt ran
112541	JA4J24A50J	Williams	Williston	ND	58802	2018	MITSUBISHI	OUTLANDER	Plug-in Hybrid Electric Vehicle (PHEV)	Not eligi due to batt ran
112603	7FCTGAAL7N	Kootenai	Worley	ID	83876	2022	RIVIAN	R1T	Battery Electric Vehicle (BEV)	Eligibi unkno as batt range not

443 rows × 17 columns

In [79]:
```
df.dropna(subset="Electric Utility",axis=0,inplace=True)
```

In [80]:
```
df["Electric Utility"].isna().sum()
```

Out[80]:
```
0
```

In [116…
```
df["Base MSRP"].value_counts()
```

Out[116]:
```
Base MSRP
0         108674
69900       1493
31950        406
52900        213
32250        158
54950        135
59900        134
```

```
39995        118
36900        100
44100         95
64950         82
33950         78
45600         76
52650         67
34995         58
36800         50
55700         47
53400         28
110950        24
98950         23
81100         19
102000        19
90700         18
75095         16
184400        12
43700         10
109000         7
89100          7
91250          4
845000         1
Name: count, dtype: int64
```

- As Base MSRP most of them are 0 so dropping the column

In [117…
```
df.drop(["Base MSRP"],axis=1,inplace=True)
```

In [81]:
```
df.isna().sum()
```

Out[81]:
```
VIN (1-10)                                           0
County                                               0
City                                                 0
State                                                0
Postal Code                                          0
Model Year                                           0
Make                                                 0
Model                                                0
Electric Vehicle Type                                0
Clean Alternative Fuel Vehicle (CAFV) Eligibility    0
Electric Range                                       0
Base MSRP                                            0
Legislative District                                 0
DOL Vehicle ID                                       0
Vehicle Location                                     0
Electric Utility                                     0
2020 Census Tract                                    0
dtype: int64
```

In [82]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Index: 112172 entries, 2 to 112633
Data columns (total 17 columns):
 #   Column                                             Non-Null Count   Dtype
---  ------                                             --------------   -----
 0   VIN (1-10)                                         112172 non-null  object
 1   County                                             112172 non-null  object
 2   City                                               112172 non-null  object
 3   State                                              112172 non-null  object
 4   Postal Code                                        112172 non-null  int64
 5   Model Year                                         112172 non-null  int64
 6   Make                                               112172 non-null  object
```

```
 7   Model                                              112172 non-null  object
 8   Electric Vehicle Type                              112172 non-null  object
 9   Clean Alternative Fuel Vehicle (CAFV) Eligibility  112172 non-null  object
 10  Electric Range                                     112172 non-null  int64
 11  Base MSRP                                          112172 non-null  int64
 12  Legislative District                               112172 non-null  float64
 13  DOL Vehicle ID                                     112172 non-null  int64
 14  Vehicle Location                                   112172 non-null  object
 15  Electric Utility                                   112172 non-null  object
 16  2020 Census Tract                                  112172 non-null  int64
dtypes: float64(1), int64(6), object(10)
memory usage: 15.4+ MB
```

Exporting cleaned data

In [122…
```
df.to_csv("Cleaned_EV_data.csv")
```

EDA

- Reading cleaned data

In [5]:
```
df = pd.read_csv("Cleaned_EV_data.csv")
```

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

Out[3]:

	Unnamed: 0	VIN (1-10)	County	City	State	Postal Code	Model Year	Make	Model	Electric Vehicle Type	Clean Alternative Fuel Vehicle (CAFV) Eligibility
0	2	JN1AZ0CP8B	Yakima	Yakima	WA	98901	2011	NISSAN	LEAF	Battery Electric Vehicle (BEV)	Clean Alternative Fuel Vehicle Eligible
1	3	1G1FW6S08H	Skagit	Concrete	WA	98237	2017	CHEVROLET	BOLT EV	Battery Electric Vehicle (BEV)	Clean Alternative Fuel Vehicle Eligible
2	4	3FA6P0SU1K	Snohomish	Everett	WA	98201	2019	FORD	FUSION	Plug-in Hybrid Electric Vehicle (PHEV)	Not eligible due to low battery range
3	5	5YJ3E1EB5J	Snohomish	Bothell	WA	98021	2018	TESLA	MODEL 3	Battery Electric Vehicle (BEV)	Clean Alternative Fuel Vehicle Eligible
4	6	1N4AZ0CP4D	Snohomish	Everett	WA	98203	2013	NISSAN	LEAF	Battery Electric Vehicle (BEV)	Clean Alternative Fuel Vehicle Eligible

Univariate

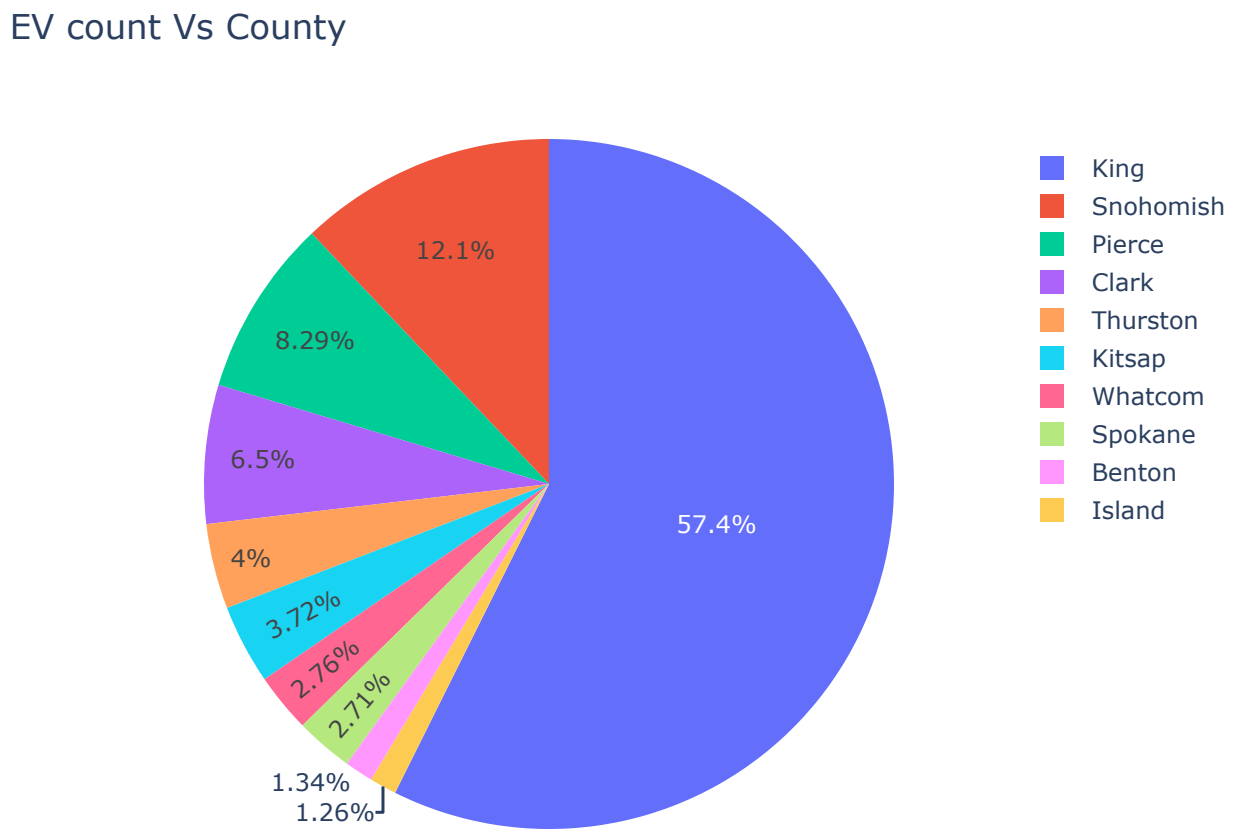
County Count w.r.t vehicles

In [6]:
```
df_county=df["County"].value_counts().reset_index().head(10)
df_county
```

Out[6]:

	County	count
0	King	58995
1	Snohomish	12414
2	Pierce	8527
3	Clark	6681
4	Thurston	4109
5	Kitsap	3828
6	Whatcom	2839
7	Spokane	2785
8	Benton	1376
9	Island	1298

In [7]:
```
fig = px.pie(df_county,values='count', names='County', title='EV count Vs County')
fig.show()
```



- The above Pie chart shows the top 10 county which have more EV's
- It is seen that King county has around 57% of total data followed by Snohomish with 12.% and remaining are less than 10%

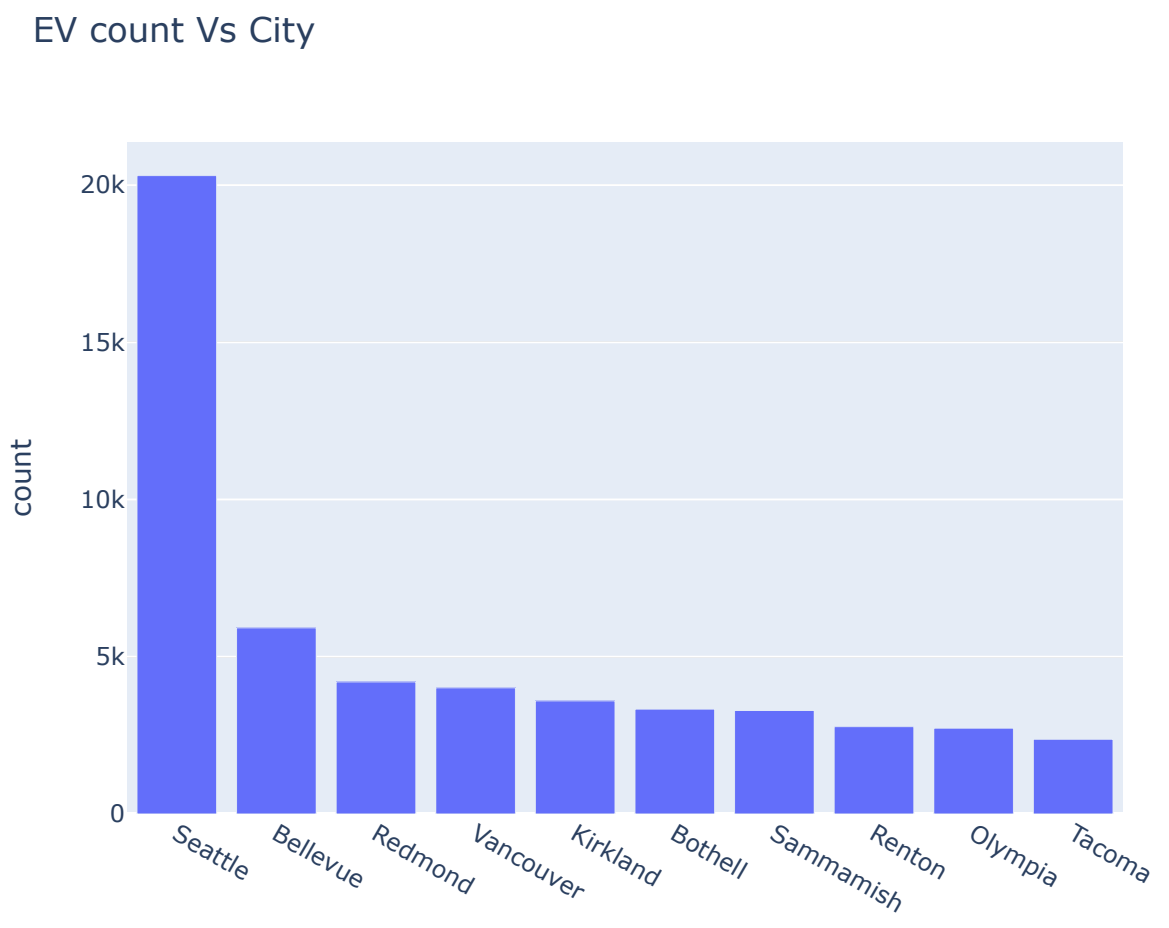
Vehicle count w.r.t City

In [8]:
```
df_city=df["City"].value_counts().reset_index().head(10)
df_city
```

Out[8]:

	City	count
0	Seattle	20300
1	Bellevue	5920
2	Redmond	4201
3	Vancouver	4013
4	Kirkland	3598
5	Bothell	3335
6	Sammamish	3292
7	Renton	2778
8	Olympia	2729
9	Tacoma	2376

In [9]:
```
fig = px.bar(df_city,x='City',y='count',title='EV count Vs City')
fig.show()
```



City

- The above Bar plot shows the top 10 Cities which have more EV's.
- Form the above bar plot it is seen that Seattle City has around 20,000 vehicles, next top city is Bellevue with vehicles around 6,000.

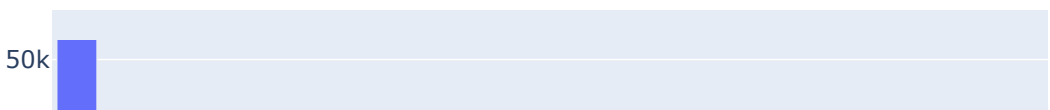
Vehicle count w.r.t Make

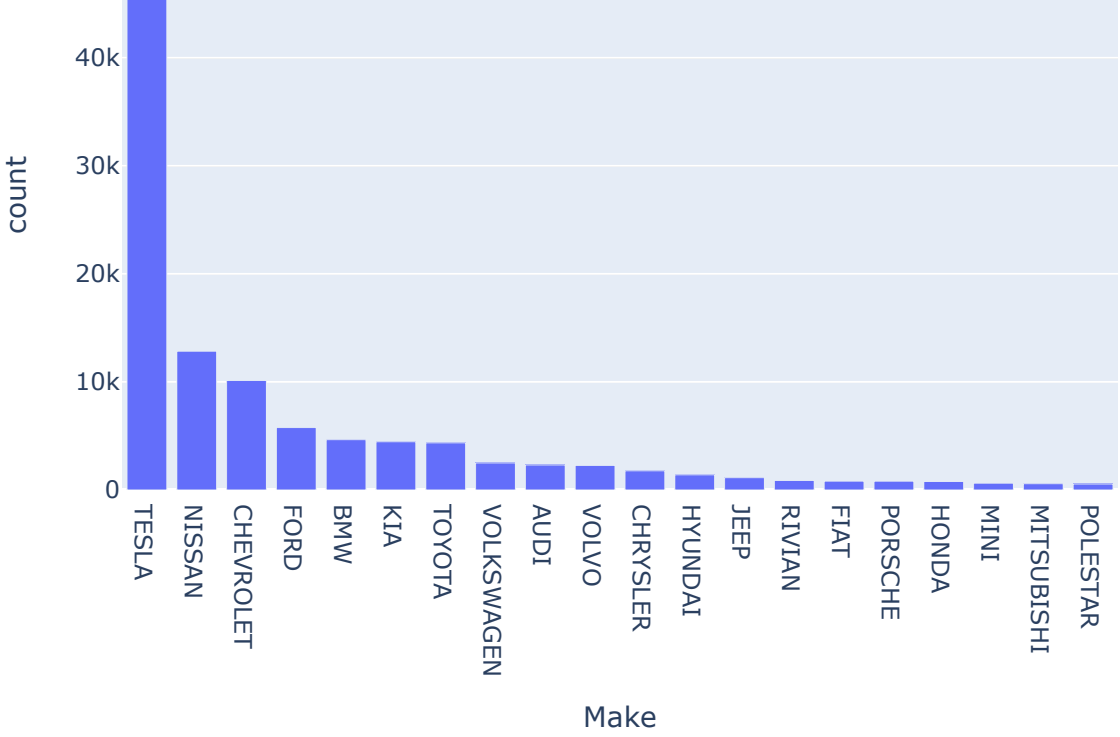
In [10]:
```
df_make=df["Make"].value_counts().reset_index().head(20)
df_make
```

Out[10]:

	Make	count
0	TESLA	51883
1	NISSAN	12846
2	CHEVROLET	10140
3	FORD	5780
4	BMW	4660
5	KIA	4469
6	TOYOTA	4368
7	VOLKSWAGEN	2507
8	AUDI	2320
9	VOLVO	2276
10	CHRYSLER	1780
11	HYUNDAI	1407
12	JEEP	1143
13	RIVIAN	883
14	FIAT	820
15	PORSCHE	817
16	HONDA	788
17	MINI	631
18	MITSUBISHI	585
19	POLESTAR	557

In [11]:
```
fig = px.bar(df_make,x='Make',y='count',title='Top 20 Brands')
fig.show()
```





- From the above bar plot it is seen that most vehicles sold in Washington State are from Tesla Brand with more than 50,000 vehicles.
- Next top brands are Nissan and Chevrolet with around 10,000.

Model vs Count

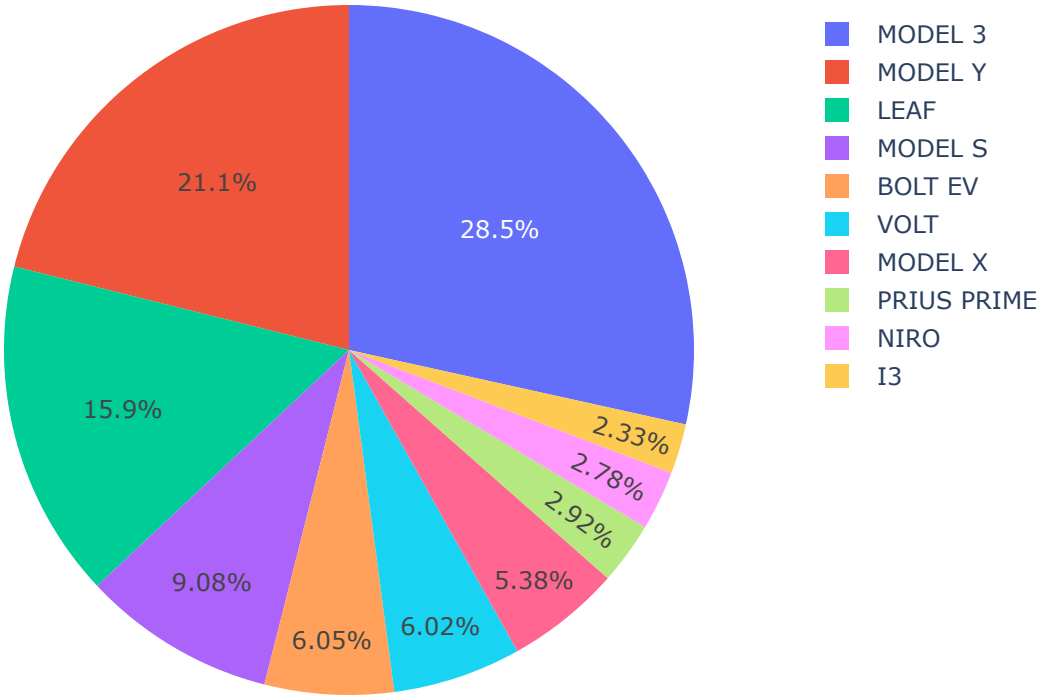
In [12]:
```
df_model=df["Model"].value_counts().reset_index().head(10)
df_model
```

Out[12]:

	Model	count
0	MODEL 3	23042
1	MODEL Y	17086
2	LEAF	12846
3	MODEL S	7346
4	BOLT EV	4895
5	VOLT	4870
6	MODEL X	4355
7	PRIUS PRIME	2365
8	NIRO	2252
9	I3	1888

In [13]:
```
fig = px.pie(df_model,values='count', names='Model', title='Top 10 EV models')
fig.show()
```

Top 10 EV models



- The above Pie Chart shows the top 10 EV models present in Washington State.
- Modle 3 and Model Y are most sold vehicles in Washington with count of 23,000 and 17,000.
- LEAF is next top sold vehicle after Model 3 and Model Y with count of 12,800.

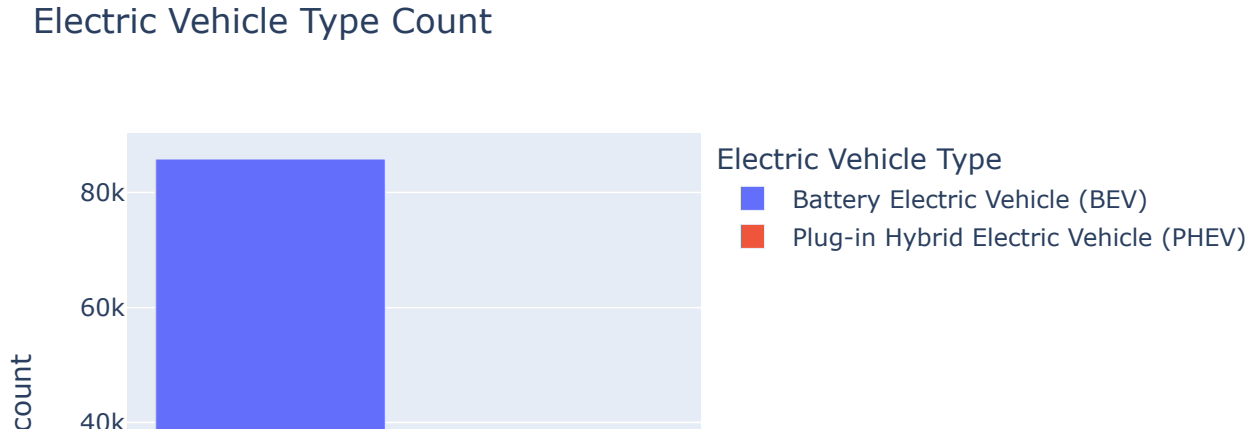
Electric Vehicle Type count

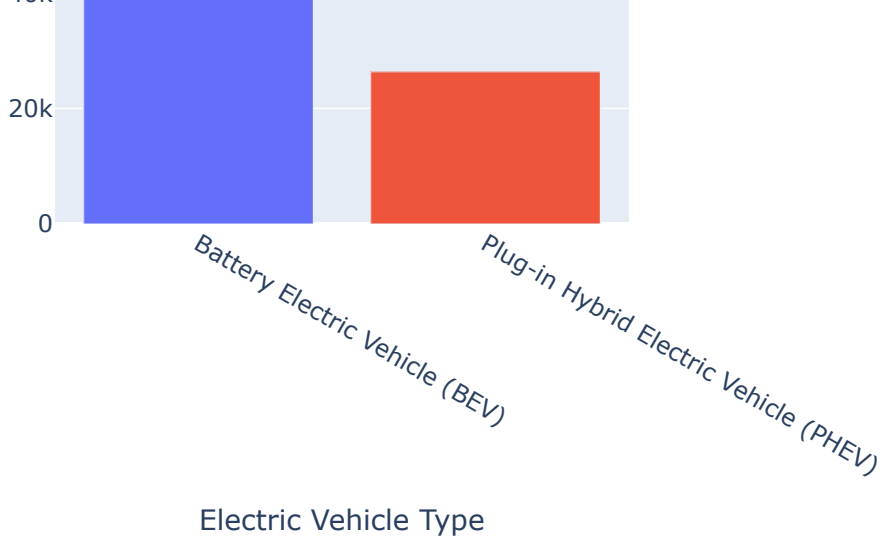
In [14]:
```
df_type=df["Electric Vehicle Type"].value_counts().reset_index()
df_type
```

Out[14]:

	Electric Vehicle Type	count
0	Battery Electric Vehicle (BEV)	85752
1	Plug-in Hybrid Electric Vehicle (PHEV)	26420

In [15]:
```
fig = px.bar(df_type,x='Electric Vehicle Type',y='count',title='Electric Vehicle Type Co
fig.show()
```





Year Vs Count

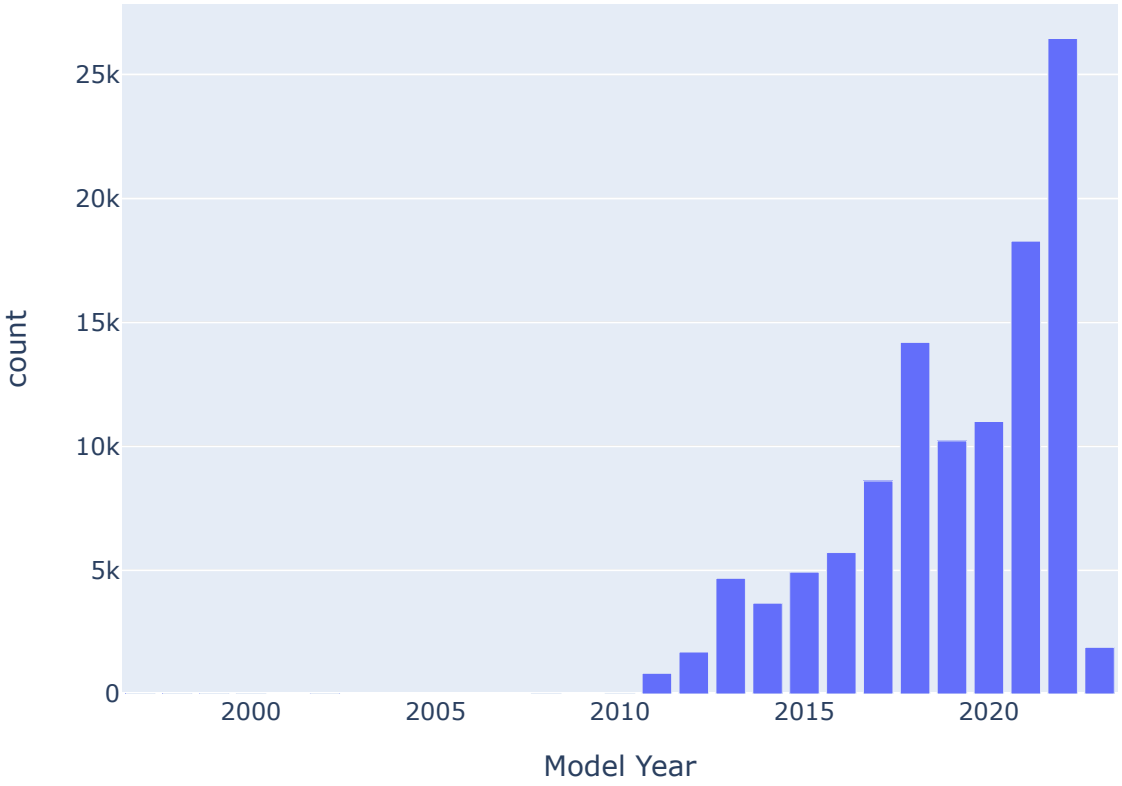
In [16]:
```
df_year=df["Model Year"].value_counts().reset_index()
df_year
```

Out[16]:

	Model Year	count
0	2022	26455
1	2021	18277
2	2018	14190
3	2020	10998
4	2019	10216
5	2017	8598
6	2016	5709
7	2015	4918
8	2013	4669
9	2014	3665
10	2023	1883
11	2012	1695
12	2011	835
13	2010	24
14	2008	23
15	2000	10
16	1999	3
17	2002	2
18	1997	1
19	1998	1

In [17]:
```
fig = px.bar(df_year,y='count',x='Model Year',title='Year wise EV count')
fig.show()
```

Year wise EV count



Bivariate

Make Vs Model

In [18]:
```
df_make_model = df.groupby(["Make","Model"]).size().reset_index(name="count")
```

In [19]:
```
df_make_model
```

Out[19]:

	Make	Model	count
0	AUDI	A3	572
1	AUDI	A7	11
2	AUDI	A8 E	3
3	AUDI	E-TRON	795
4	AUDI	E-TRON GT	75
...	...	...	...
110	VOLVO	S90	25
111	VOLVO	V60	10
112	VOLVO	XC40	495
113	VOLVO	XC60	697

114	VOLVO	XC90	817

115 rows × 3 columns

In [20]:
```
df_make_model.sort_values(by="count",ascending=False,inplace=True)
```

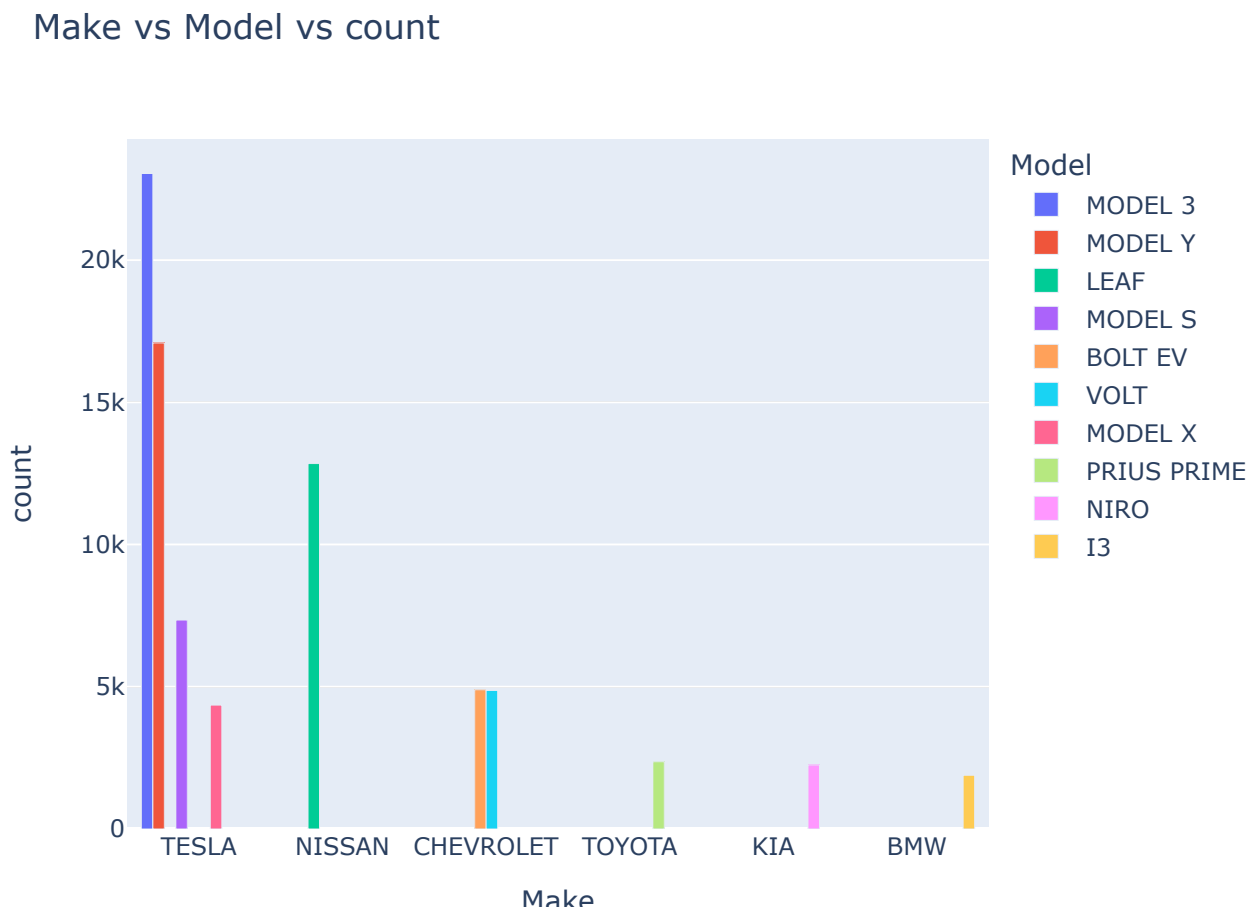
In [21]:
```
df_make_model=df_make_model.head(10)
```

In [22]:
```
df_make_model
```

Out[22]:

	Make	Model	count
95	TESLA	MODEL 3	23042
98	TESLA	MODEL Y	17086
81	NISSAN	LEAF	12846
96	TESLA	MODEL S	7346
27	CHEVROLET	BOLT EV	4895
30	CHEVROLET	VOLT	4870
97	TESLA	MODEL X	4355
102	TOYOTA	PRIUS PRIME	2365
57	KIA	NIRO	2252
18	BMW	I3	1888

In [23]:
```
fig = px.bar(df_make_model, x="Make", y="count",color="Model",barmode="group",title="Mak
fig.show()
```



Make

- From the above bar plot it is seen that Tesla brand has more Popularity in Washington when compared to other Brands.
- And even in Tesla Brand Model 3 is more sold followed by Model Y.

Make Vs Electric Range

In [24]:
```
df_range=df.groupby(["Make"])["Electric Range"].mean().reset_index()
df_range
```

Out[24]:

	Make	Electric Range
0	AUDI	62.628448
1	AZURE DYNAMICS	56.000000
2	BENTLEY	18.666667
3	BMW	46.681545
4	CADILLAC	35.537037
5	CHEVROLET	109.862032
6	CHRYSLER	32.360674
7	FIAT	85.628049
8	FISKER	33.000000
9	FORD	16.840484
10	GENESIS	0.000000
11	HONDA	46.616751
12	HYUNDAI	48.196162
13	JAGUAR	207.165138
14	JEEP	22.702537
15	KIA	67.684046
16	LAND ROVER	19.000000
17	LEXUS	37.000000
18	LINCOLN	23.095808
19	LUCID MOTORS	0.000000
20	MERCEDES-BENZ	22.123260
21	MINI	26.646593
22	MITSUBISHI	26.770940
23	NISSAN	89.328429
24	POLESTAR	40.576302
25	PORSCHE	54.139535
26	RIVIAN	0.000000

27	SMART	62.276753
28	SUBARU	16.711864
29	TESLA	118.095368
30	TH!NK	100.000000
31	TOYOTA	26.005495
32	VOLKSWAGEN	43.801755
33	VOLVO	14.399824

In [25]:
```
df_range=df_range.sort_values(by="Electric Range",ascending=False)
```

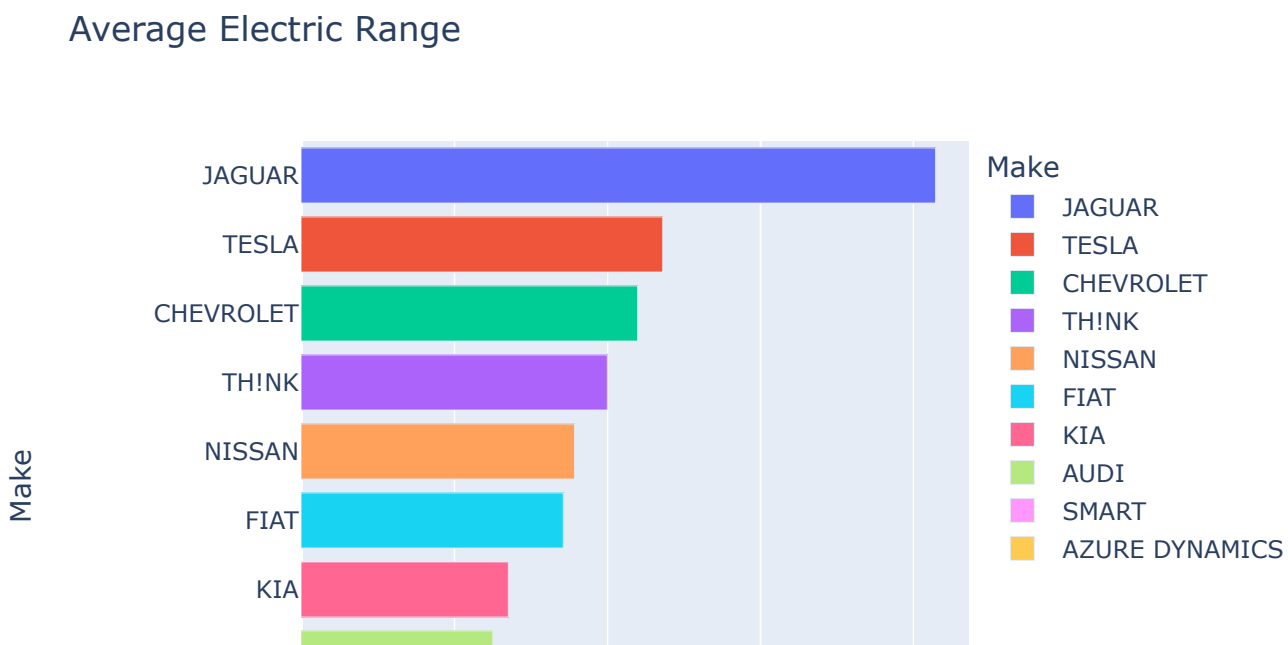
In [26]:
```
df_range=df_range.head(10)
```

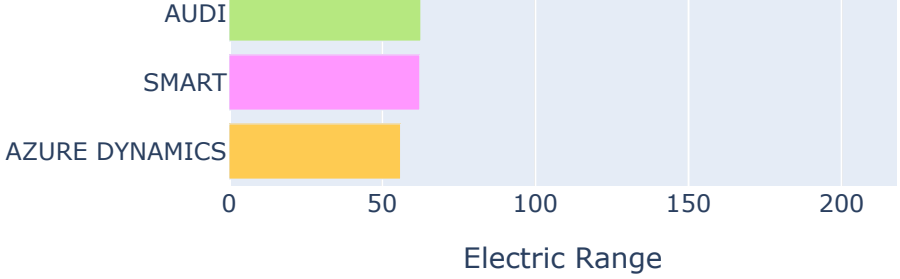
In [27]:
```
df_range
```

Out[27]:

	Make	Electric Range
13	JAGUAR	207.165138
29	TESLA	118.095368
5	CHEVROLET	109.862032
30	TH!NK	100.000000
23	NISSAN	89.328429
7	FIAT	85.628049
15	KIA	67.684046
0	AUDI	62.628448
27	SMART	62.276753
1	AZURE DYNAMICS	56.000000

In [28]:
```
fig = px.bar(df_range, y="Make", x="Electric Range",color="Make",title="Average Electric
fig.show()
```





- From the above bar plot it is seen that average Electric Range of Jaguar is around 200 followed by Tesla With 118.

County VS Make

In [29]:
```
df_county_make1=df.groupby(["County","Make"]).size().reset_index(name="count")
```

In [30]:
```
df_county_make1
```

Out[30]:

	County	Make	count
0	Adams	AUDI	1
1	Adams	BMW	1
2	Adams	CHEVROLET	6
3	Adams	CHRYSLER	1
4	Adams	FORD	5
...	...	...	...
819	Yakima	SUBARU	1
820	Yakima	TESLA	265
821	Yakima	TOYOTA	43
822	Yakima	VOLKSWAGEN	12
823	Yakima	VOLVO	10

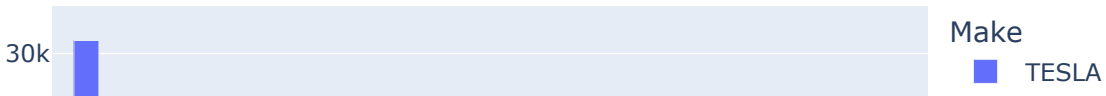
824 rows × 3 columns

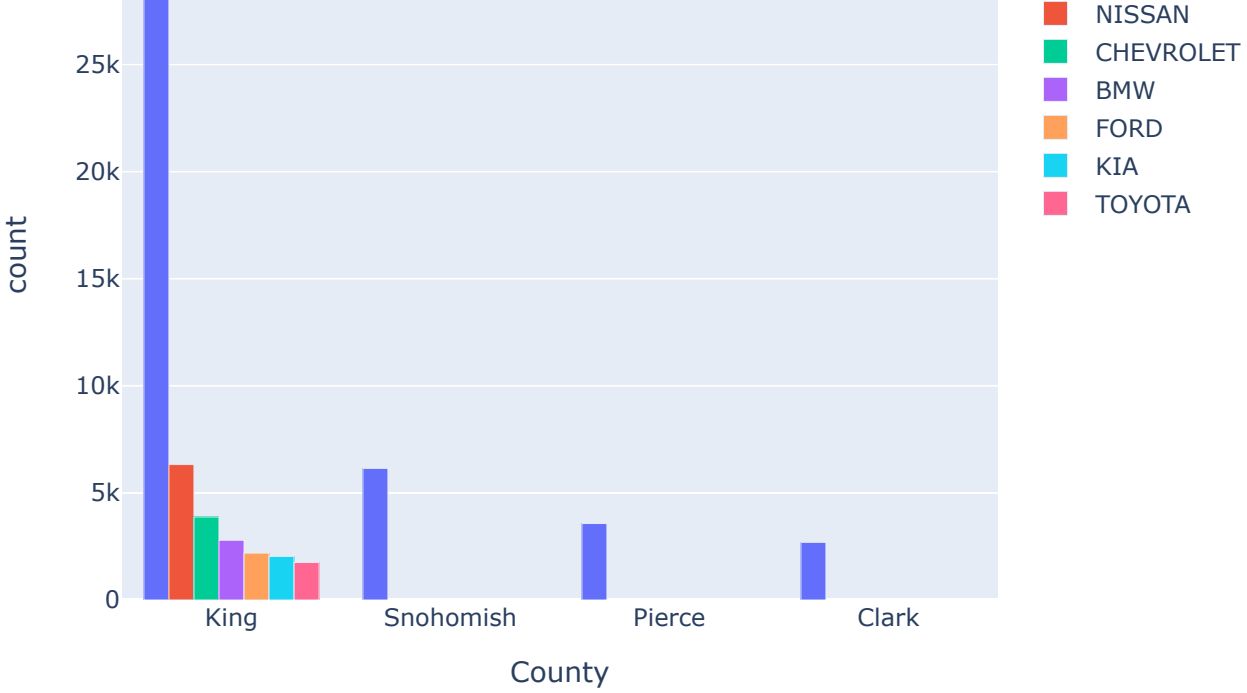
In [31]:
```
df_county_make1.sort_values(by="count",inplace=True,ascending=False)
```

In [32]:
```
df_county_make1 = df_county_make1.head(10)
```

In [33]:
```
fig = px.bar(df_county_make1, x="County", y="count",color="Make",barmode="group",title="
fig.show()
```

County Vs Make





- From the above bar plot it is seen that King county has highest make with Tesla topping at 30k

Make Vs Electric Vehicle Type

In [34]:
```
df_make_Electric_Vehicle_Type = df.groupby(["Electric Vehicle Type","Make"]).size().rese
```

In [35]:
```
df_make_Electric_Vehicle_Type.sort_values(by="count",ascending=False,inplace=True)
```

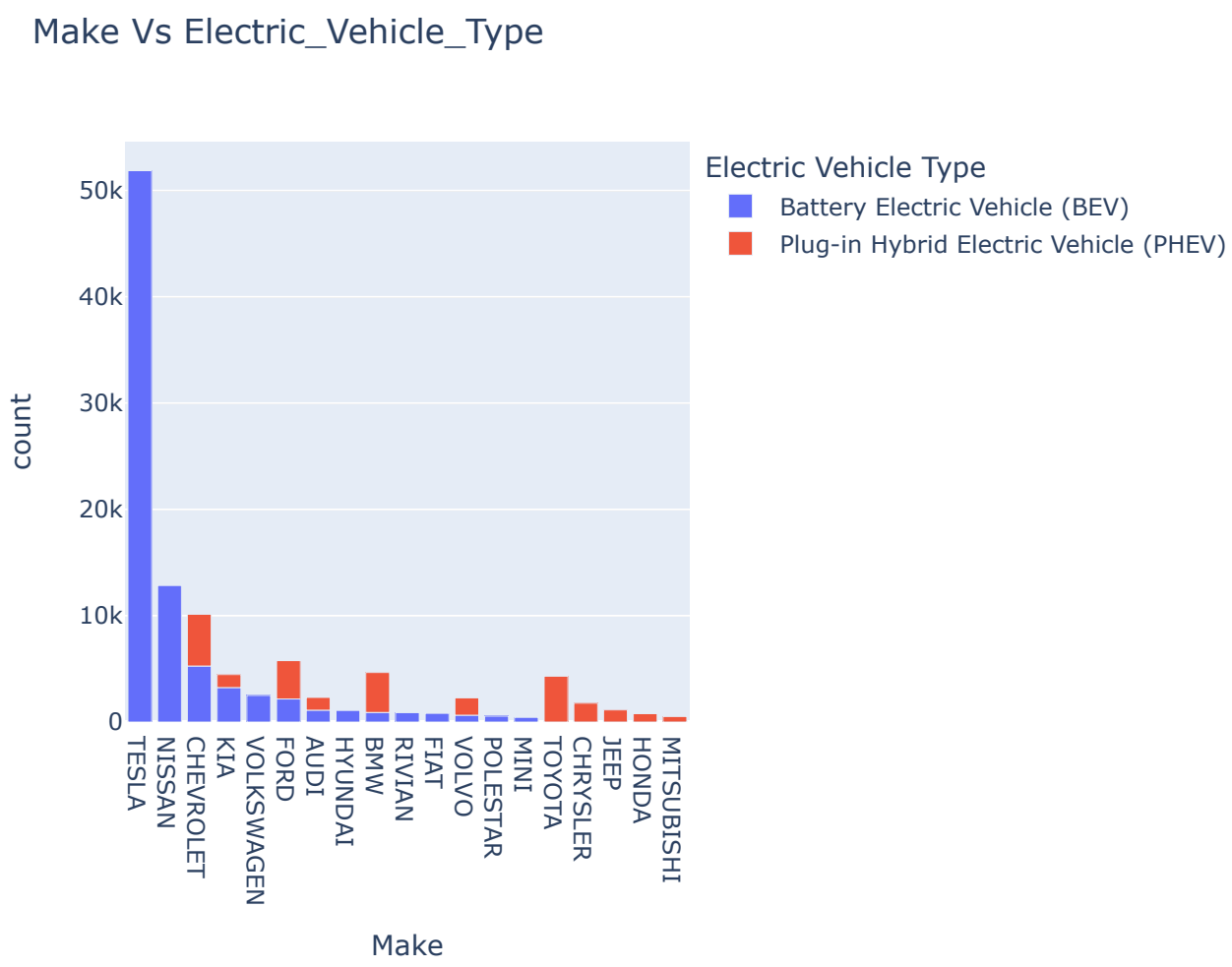
In [36]:
```
df_make_Electric_Vehicle_Type.head(25)
```

Out[36]:

	Electric Vehicle Type	Make	count
20	Battery Electric Vehicle (BEV)	TESLA	51883
14	Battery Electric Vehicle (BEV)	NISSAN	12846
3	Battery Electric Vehicle (BEV)	CHEVROLET	5270
29	Plug-in Hybrid Electric Vehicle (PHEV)	CHEVROLET	4870
45	Plug-in Hybrid Electric Vehicle (PHEV)	TOYOTA	4311
27	Plug-in Hybrid Electric Vehicle (PHEV)	BMW	3757
32	Plug-in Hybrid Electric Vehicle (PHEV)	FORD	3609
9	Battery Electric Vehicle (BEV)	KIA	3246
23	Battery Electric Vehicle (BEV)	VOLKSWAGEN	2507
5	Battery Electric Vehicle (BEV)	FORD	2171
30	Plug-in Hybrid Electric Vehicle (PHEV)	CHRYSLER	1780
46	Plug-in Hybrid Electric Vehicle (PHEV)	VOLVO	1629
36	Plug-in Hybrid Electric Vehicle (PHEV)	KIA	1223
25	Plug-in Hybrid Electric Vehicle (PHEV)	AUDI	1201
35	Plug-in Hybrid Electric Vehicle (PHEV)	JEEP	1143

0	Battery Electric Vehicle (BEV)	AUDI	1119
7	Battery Electric Vehicle (BEV)	HYUNDAI	1091
2	Battery Electric Vehicle (BEV)	BMW	903
17	Battery Electric Vehicle (BEV)	RIVIAN	883
4	Battery Electric Vehicle (BEV)	FIAT	820
33	Plug-in Hybrid Electric Vehicle (PHEV)	HONDA	788
24	Battery Electric Vehicle (BEV)	VOLVO	647
15	Battery Electric Vehicle (BEV)	POLESTAR	557
42	Plug-in Hybrid Electric Vehicle (PHEV)	MITSUBISHI	520
12	Battery Electric Vehicle (BEV)	MINI	439

In [37]:
```
fig = px.bar(df_make_Electric_Vehicle_Type.head(25), x="Make", y="count",color="Electric
fig.show()
```



- From the above Bar plot it is seen that Telsa has only BEV vehicles whereas Chevrolet, Kia, Ford, Audi, BMW, Volvo have both BEV and PHEV

City Vs Make

In [38]:
```
df_city_make=df.groupby(["City","Make"]).size().reset_index(name="count")
```

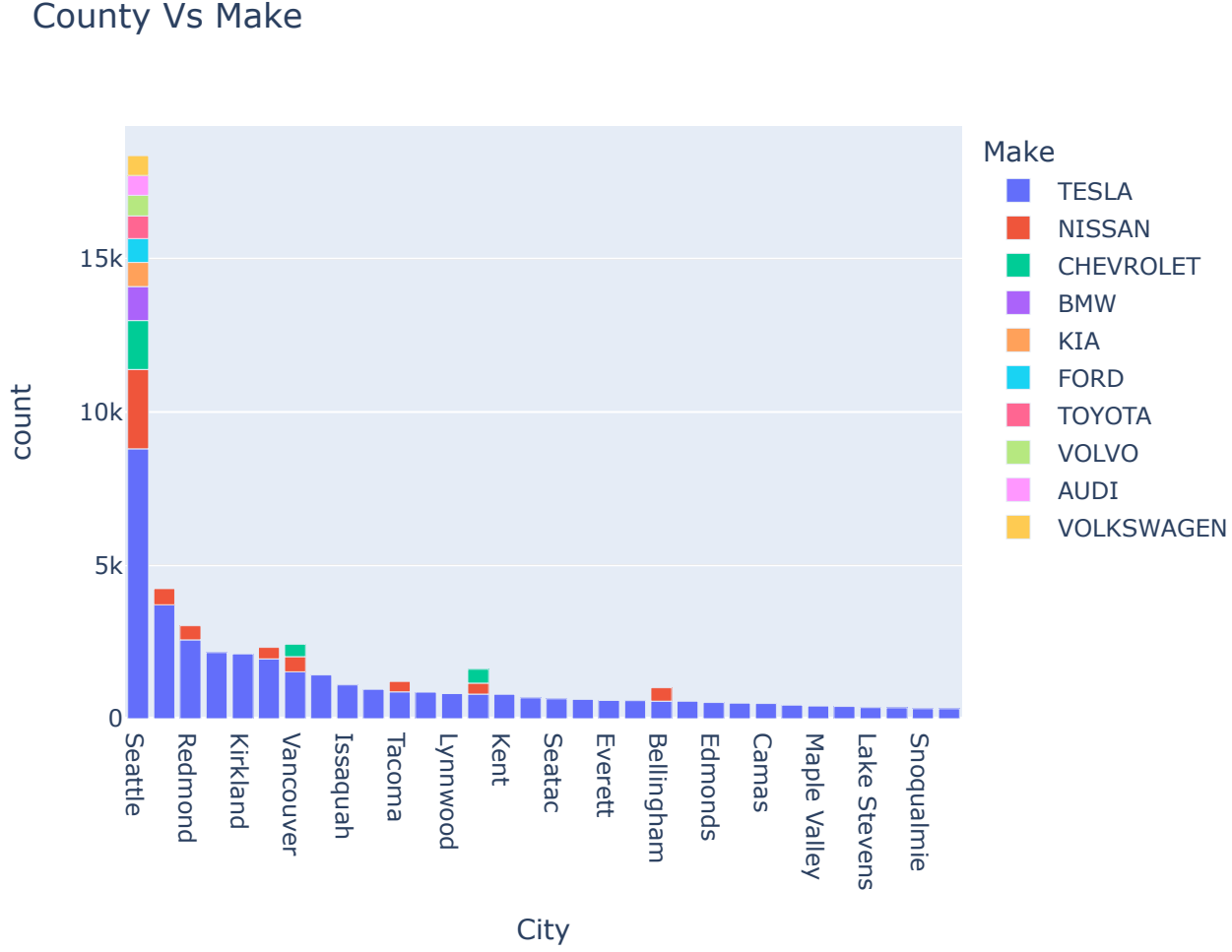
In [39]:
```
df_city_make.sort_values(by="count",ascending=False,inplace=True)
```

In [40]:
```
df_city_make.head(30)
```

Out[40]:

	City	Make	count
3545	Seattle	TESLA	8800
261	Bellevue	TESLA	3714
3539	Seattle	NISSAN	2586
3277	Redmond	TESLA	2570
3472	Sammamish	TESLA	2156
1862	Kirkland	TESLA	2112
402	Bothell	TESLA	1950
3521	Seattle	CHEVROLET	1595
4224	Vancouver	TESLA	1529
3307	Renton	TESLA	1425
3519	Seattle	BMW	1109
1691	Issaquah	TESLA	1102
2393	Mercer Island	TESLA	957
4011	Tacoma	TESLA	875
4433	Woodinville	TESLA	866
2214	Lynnwood	TESLA	818
2837	Olympia	TESLA	801
1808	Kent	TESLA	795
3531	Seattle	KIA	787
3525	Seattle	FORD	778
3546	Seattle	TOYOTA	739
3848	Spokane	TESLA	680
3548	Seattle	VOLVO	672
3513	Seatac	TESLA	648
3517	Seattle	AUDI	648
3547	Seattle	VOLKSWAGEN	645
3730	Snohomish	TESLA	630
1268	Everett	TESLA	596
1473	Gig Harbor	TESLA	589
290	Bellingham	TESLA	571

In [41]:
```
fig = px.bar(df_city_make.head(50), x="City", y="count",color="Make",title="County Vs Ma
fig.show()
```



Choropleth Plot of Washington

In [42]:
```
df.head()
```

Out[42]:

	Unnamed: 0	VIN (1-10)	County	City	State	Postal Code	Model Year	Make	Model	Electric Vehicle Type	Clean Alternative Fuel Vehicle (CAFV) Eligibility
0	2	JN1AZ0CP8B	Yakima	Yakima	WA	98901	2011	NISSAN	LEAF	Battery Electric Vehicle (BEV)	Clean Alternative Fuel Vehicle Eligible
1	3	1G1FW6S08H	Skagit	Concrete	WA	98237	2017	CHEVROLET	BOLT EV	Battery Electric Vehicle (BEV)	Clean Alternative Fuel Vehicle Eligible
2	4	3FA6P0SU1K	Snohomish	Everett	WA	98201	2019	FORD	FUSION	Plug-in Hybrid Electric Vehicle (PHEV)	Not eligible due to low battery range
3	5	5YJ3E1EB5J	Snohomish	Bothell	WA	98021	2018	TESLA	MODEL 3	Battery Electric Vehicle (BEV)	Clean Alternative Fuel Vehicle Eligible
4	6	1N4AZ0CP4D	Snohomish	Everett	WA	98203	2013	NISSAN	LEAF	Battery	Clean

Electric Vehicle (BEV)	Alternative Fuel Vehicle Eligible

In [43]:
```
df.groupby(["Postal Code"]).size().reset_index(name="EV count")
```

Out[43]:

	Postal Code	EV count
0	98001	465
1	98002	165
2	98003	312
3	98004	2001
4	98005	829
...	...	...
511	99360	4
512	99361	8
513	99362	248
514	99402	9
515	99403	39

516 rows × 2 columns

In [44]:
```
df_city=df.groupby(["City"]).size().reset_index(name="EV count")
```

In [45]:
```
df_city
```

Out[45]:

	City	EV count
0	Aberdeen	99
1	Acme	6
2	Addy	3
3	Airway Heights	16
4	Algona	24
...	...	...
430	Yacolt	29
431	Yakima	400
432	Yarrow Point	116
433	Yelm	189
434	Zillah	22

435 rows × 2 columns

In [46]:
```
import requests
from urllib.request import urlopen
import json
```

```
with urlopen('https://raw.githubusercontent.com/OpenDataDE/State-zip-code-GeoJSON/master
    counties = json.load(response)
```

In [47]:
```
Washington = json.load(open("wa_washington_zip_codes_geo.min.json", "r"))
```

In [48]:
```
Washington["features"][0]
```

Out[48]:

```
{'type': 'Feature',
 'properties': {'STATEFP10': '53',
  'ZCTA5CE10': '98822',
  'GEOID10': '5398822',
  'CLASSFP10': 'B5',
  'MTFCC10': 'G6350',
  'FUNCSTAT10': 'S',
  'ALAND10': 1131837710,
  'AWATER10': 5582389,
  'INTPTLAT10': '+47.9019257',
  'INTPTLON10': '-120.5504512',
  'PARTFLG10': 'N'},
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```

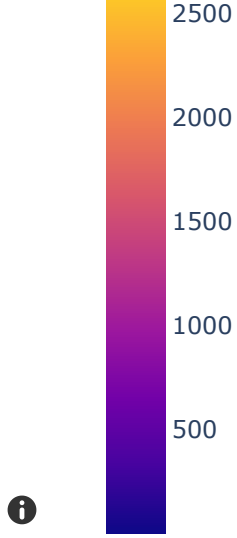
In [49]:
```
df_choro = df.groupby(["City","Postal Code"]).size().reset_index(name="EV count")
df_choro
```

Out[49]:

	City	Postal Code	EV count
0	Aberdeen	98520	99
1	Acme	98220	6
2	Addy	99101	3
3	Airway Heights	99001	16
4	Algona	98001	24
...	...	...	...
678	Yarrow Point	98004	116
679	Yelm	98597	189
680	Zillah	98932	1
681	Zillah	98951	1
682	Zillah	98953	20

683 rows × 3 columns

In [50]:
```
fig = px.choropleth_mapbox(
    df_choro,
    locations="Postal Code",
    featureidkey='properties.ZCTA5CE10',
    geojson=counties,
    color="EV count",
    hover_name="City",
    hover_data=["EV count"],
    title="Count of EV Vehicles",
    mapbox_style="carto-positron",
    center={"lat": 47.23166874361465, "lon": -119.85514005647997},
    zoom=6,
    opacity=0.5,
)
fig.show()
```



- The above Choropleth map shows the count of EV's present in Each City.

Bar chart Race

In [61]:
```
#!pip install bar-chart-race
```

In [52]:
```
import bar_chart_race as bcr
```

In [53]:
```
df
```

Out[53]:

	Unnamed: 0	VIN (1-10)	County	City	State	Postal Code	Model Year	Make	Model	Electric Vehicle Type	Alt El
0	2	JN1AZ0CP8B	Yakima	Yakima	WA	98901	2011	NISSAN	LEAF	Battery Electric Vehicle (BEV)	Alt Fue
1	3	1G1FW6S08H	Skagit	Concrete	WA	98237	2017	CHEVROLET	BOLT EV	Battery Electric Vehicle (BEV)	Alt Fue
2	4	3FA6P0SU1K	Snohomish	Everett	WA	98201	2019	FORD	FUSION	Plug-in Hybrid Electric Vehicle (PHEV)	No du
3	5	5YJ3E1EB5J	Snohomish	Bothell	WA	98021	2018	TESLA	MODEL 3	Battery Electric Vehicle (BEV)	Alt Fue

4	6	1N4AZ0CP4D	Snohomish	Everett	WA	98203	2013	NISSAN	LEAF	Battery Electric Vehicle (BEV)	Alt Fue
...	...	...	...	...	...	...	...	...	...	...	
112167	112629	7SAYGDEF2N	King	Duvall	WA	98019	2022	TESLA	MODEL Y	Battery Electric Vehicle (BEV)	
112168	112630	1N4BZ1CP7K	San Juan	Friday Harbor	WA	98250	2019	NISSAN	LEAF	Battery Electric Vehicle (BEV)	Alt Fue
112169	112631	1FMCU0KZ4N	King	Vashon	WA	98070	2022	FORD	ESCAPE	Plug-in Hybrid Electric Vehicle (PHEV)	Alt Fue
112170	112632	KNDCD3LD4J	King	Covington	WA	98042	2018	KIA	NIRO	Plug-in Hybrid Electric Vehicle (PHEV)	Not du
112171	112633	YV4BR0CL8N	King	Covington	WA	98042	2022	VOLVO	XC90	Plug-in Hybrid Electric Vehicle (PHEV)	Not du

112172 rows × 17 columns

In [54]:
```
df_make_count=df.groupby(["Make"]).size().reset_index(name="count")
```

In [55]:
```
df_make_count.sort_values(by="count",ascending=False,inplace=True)
```

In [56]:
```
df_make_del = df_make_count.tail(15)
```

In [57]:
```
names=df_make_del["Make"].tolist()
```

In [58]:
```
df_bcr = pd.crosstab(index=df["Model Year"],columns=df["Make"])
```

In [59]:
```
df_bcr.drop(names,axis=1,inplace=True)
```

In [60]:
```
bcr.bar_chart_race(df_bcr,filename='EV_bar_chart_race.gif',n_bars=10,steps_per_period=5)
```

```
C:\Users\susmi\anaconda3\lib\site-packages\bar_chart_race\_make_chart.py:286: UserWarnin
g:

FixedFormatter should only be used together with FixedLocator

C:\Users\susmi\anaconda3\lib\site-packages\bar_chart_race\_make_chart.py:287: UserWarnin
g:

FixedFormatter should only be used together with FixedLocator

MovieWriter imagemagick unavailable; using Pillow instead.
```

- The above racing bar chart shows the Evolution of EV's in different car brands and it is seen that Tesla crushed all other Brands as Years pass by.

In [ ]: