Exploratory Data Analysis On Electric Vehicle

What is Exploratory Data Analysis?

- Exploratory Data Analysis (EDA) is the process of analyzing a dataset in order to understand its main characteristics, patterns and identify anomalies. EDA is often the first step in the data analysis process.
- It involves using different graphs and plots to help visualise the data and also uses statistical methods to draw inferences from the data.
- The goal of EDA is not to arrive at a certain right answer or to confirm a pre-defined hypothesis. It is an exploratory process to draw inferences and get ideas on how the data can be further utilised to predict certain outcomes/develop ML models

- An electric vehicle (EV) is a vehicle that uses one or more electric motors for propulsion. It can be powered by a collector system, with electricity from extravehicular sources, or it can be powered autonomously by a battery (sometimes charged by solar panels, or by converting fuel to electricity using fuel cells or a generator).
- EVs include, but are not limited to, road and rail vehicles, surface and underwater vessels, electric aircraft , and electric spacecraft.
- For road vehicles, together with other emerging automotive technologies such as autonomous driving, connected vehicles, and shared mobility, EVs form a future mobility vision called Connected, Autonomous, Shared, and Electric (CASE) Mobility.
- EVs first came into existence in the late 19th century, when electricity was among the preferred methods for motor vehicle propulsion, providing a level of comfort and ease of operation that could not be achieved by the gasoline cars of the time.
- Internal combustion engines were the dominant propulsion method for cars and trucks for about 100 years, but electric power remained commonplace in other vehicle types, such as trains and smaller vehicles of all types.
- Data set link : https://drive.google.com/file/d/1P742LU5OTXbfFG2F6drbABk1O8UGf4Cd/view?usp=sharing ## About Dataset This dataset shows the Battery Electric Vehicles (BEVs) and Plug-in Hybrid Electric Vehicles (PHEVs) that are currently registered through the Washington State Department of Licensing (DOL).

1.A Battery Electric Vehicle (BEV) is an all-electric vehicle using one or more batteries to store the electrical energy that powers the motor and is charged by plugging the vehicle into an electric power source.

2 Alternative Fuel Vehicle (CAFV) Eligibility is based on the fuel requirement and electric-only range requirement as outlined in RCW 82.08.809 and RCW 82.12.809 to be eligible for Alternative Fuel Vehicles retail sales and Washington State use tax exemptions.

3.Monthly count of vehicles for a county may change from this report and prior reports. Processes were implemented to more accurately assign county at the time of registration.

4.Electric Range is no longer maintained for Battery Electric Vehicles (BEV) because new BEVs have an electric range of 30 miles or more. Zero (0) will be entered where the electric range has not been researched.

5.Field 'Electric Utility' was added starting with the publication in March 2022.

6.Field '2020 Census Tract' was added starting with the publication in June 2022.

In [ ]:

Importing Required Libraries

In [59]:
```
import pandas as pd
import numpy as np
import plotly.express as px
import warnings
warnings.filterwarnings("ignore")
import matplotlib.pyplot as plt

df=pd.read_csv(r"C:\Users\Irfan\Downloads\dataset.csv")

df
```

Out[59]:

	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	L
0	JTMEB3FV6N	Monroe	Key West	FL	33040	2022	TOYOTA	RAV4 PRIME	Plug-in Hybrid Electric Vehicle (PHEV)	Clean Alternative Fuel Vehicle Eligible	42	0	
1	1G1RD6E45D	Clark	Laughlin	NV	89029	2013	CHEVROLET	VOLT	Plug-in Hybrid Electric Vehicle (PHEV)	Clean Alternative Fuel Vehicle Eligible	38	0	
2	JN1AZ0CP8B	Yakima	Yakima	WA	98901	2011	NISSAN	LEAF	Battery Electric Vehicle (BEV)	Clean Alternative Fuel Vehicle Eligible	73	0	
3	1G1FW6S08H	Skagit	Concrete	WA	98237	2017	CHEVROLET	BOLT EV	Battery Electric Vehicle (BEV)	Clean Alternative Fuel Vehicle Eligible	238	0	
4	3FA6P0SU1K	Snohomish	Everett	WA	98201	2019	FORD	FUSION	Plug-in Hybrid Electric Vehicle (PHEV)	Not eligible due to low battery range	26	0	
...	...	...	...	...	...	...	...	...	...	...	...	...	
112629	7SAYGDEF2N	King	Duvall	WA	98019	2022	TESLA	MODEL Y	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...	0	0	
112630	1N4BZ1CP7K	San Juan	Friday Harbor	WA	98250	2019	NISSAN	LEAF	Battery Electric Vehicle (BEV)	Clean Alternative Fuel Vehicle Eligible	150	0	
112631	1FMCU0KZ4N	King	Vashon	WA	98070	2022	FORD	ESCAPE	Plug-in Hybrid Electric Vehicle (PHEV)	Clean Alternative Fuel Vehicle Eligible	38	0	
112632	KNDCD3LD4J	King	Covington	WA	98042	2018	KIA	NIRO	Plug-in Hybrid Electric Vehicle (PHEV)	Not eligible due to low battery range	26	0	
112633	YV4BR0CL8N	King	Covington	WA	98042	2022	VOLVO	XC90	Plug-in Hybrid Electric Vehicle (PHEV)	Not eligible due to low battery range	18	0	

112634 rows × 17 columns

In [2]:
```
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 [3]:
```
df.duplicated().sum()
```

Out[3]:
```
0
```

In [4]:
```
print(len(df.columns))
df.columns
```

```
17
```

Out[4]:
```
Index(['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', 'Legislative District', 'DOL Vehicle ID',
       'Vehicle Location', 'Electric Utility', '2020 Census Tract'],
      dtype='object')
```

In [5]:
```
df.head()
```

Out[5]:

	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	Legislati Distri
0	JTMEB3FV6N	Monroe	Key West	FL	33040	2022	TOYOTA	RAV4 PRIME	Plug-in Hybrid Electric Vehicle (PHEV)	Clean Alternative Fuel Vehicle Eligible	42	0	Na
1	1G1RD6E45D	Clark	Laughlin	NV	89029	2013	CHEVROLET	VOLT	Plug-in Hybrid Electric Vehicle (PHEV)	Clean Alternative Fuel Vehicle Eligible	38	0	Na
2	JN1AZ0CP8B	Yakima	Yakima	WA	98901	2011	NISSAN	LEAF	Battery Electric Vehicle (BEV)	Clean Alternative Fuel Vehicle Eligible	73	0	15
3	1G1FW6S08H	Skagit	Concrete	WA	98237	2017	CHEVROLET	BOLT EV	Battery Electric Vehicle (BEV)	Clean Alternative Fuel Vehicle Eligible	238	0	39
4	3FA6P0SU1K	Snohomish	Everett	WA	98201	2019	FORD	FUSION	Plug-in Hybrid Electric Vehicle (PHEV)	Not eligible due to low battery range	26	0	38

In [6]:
```
df.shape
```

Out[6]:
```
(112634, 17)
```

unique values

In [7]:
```
cols = df.columns
def Unique_Values():
    for i in np.arange(0,len(cols)):
        print('{} column have {} number of unique values  out of {}'.format( cols[i],df[cols[i]].nunique(), len
Unique_Values()
```

```
VIN (1-10) column have 7548 number of unique values  out of 112634

County column have 165 number of unique values  out of 112634

City column have 629 number of unique values  out of 112634

State column have 45 number of unique values  out of 112634

Postal Code column have 773 number of unique values  out of 112634

Model Year column have 20 number of unique values  out of 112634

Make column have 34 number of unique values  out of 112634

Model column have 114 number of unique values  out of 112634

Electric Vehicle Type column have 2 number of unique values  out of 112634

Clean Alternative Fuel Vehicle (CAFV) Eligibility column have 3 number of unique values  out of 112634

Electric Range column have 101 number of unique values  out of 112634

Base MSRP column have 30 number of unique values  out of 112634

Legislative District column have 49 number of unique values  out of 112634

DOL Vehicle ID column have 112634 number of unique values  out of 112634

Vehicle Location column have 758 number of unique values  out of 112634

Electric Utility column have 73 number of unique values  out of 112634

2020 Census Tract column have 2026 number of unique values  out of 112634
```

Null values

In [8]:
```
cols = df.columns
def Null_Values():
    for i in np.arange(0,len(cols)):
        print('{} column have {} number of Null values  out of {}'.format( cols[i],df[cols[i]].isnull().sum(),
Null_Values()
```

```
VIN (1-10) column have 0 number of Null values  out of 112634

County column have 0 number of Null values  out of 112634

City column have 0 number of Null values  out of 112634

State column have 0 number of Null values  out of 112634

Postal Code column have 0 number of Null values  out of 112634

Model Year column have 0 number of Null values  out of 112634

Make column have 0 number of Null values  out of 112634

Model column have 20 number of Null values  out of 112634

Electric Vehicle Type column have 0 number of Null values  out of 112634

Clean Alternative Fuel Vehicle (CAFV) Eligibility column have 0 number of Null values  out of 112634

Electric Range column have 0 number of Null values  out of 112634

Base MSRP column have 0 number of Null values  out of 112634

Legislative District column have 286 number of Null values  out of 112634

DOL Vehicle ID column have 0 number of Null values  out of 112634

Vehicle Location column have 24 number of Null values  out of 112634

Electric Utility column have 443 number of Null values  out of 112634

2020 Census Tract column have 0 number of Null values  out of 112634
```

In [9]:
```
# to view the missing percentages
missing_percentges=df.isnull().sum()/len(df)
missing_percentges
```

Out[9]:
```
VIN (1-10)                                           0.000000
County                                               0.000000
City                                                 0.000000
State                                                0.000000
Postal Code                                          0.000000
Model Year                                           0.000000
Make                                                 0.000000
Model                                                0.000178
Electric Vehicle Type                                0.000000
Clean Alternative Fuel Vehicle (CAFV) Eligibility    0.000000
Electric Range                                       0.000000
Base MSRP                                            0.000000
Legislative District                                 0.002539
DOL Vehicle ID                                       0.000000
Vehicle Location                                     0.000213
Electric Utility                                     0.003933
2020 Census Tract                                    0.000000
dtype: float64
```

Handling The Missing Values

- For handling the missing values we know the distributions of the variables by using statistics and vizualization techniques
- To fill the null values
- for numerical variables we use mean or median
- Mean is impact with outliers if ouliers present in the data we use median.
- if our data doesn't contain outliers then we use mean (to reduce the time complexity)
- for categorical(object)we use mode

So in our data Model,Legislative District,Vehicle Location,Electric Utility columns having missing values.

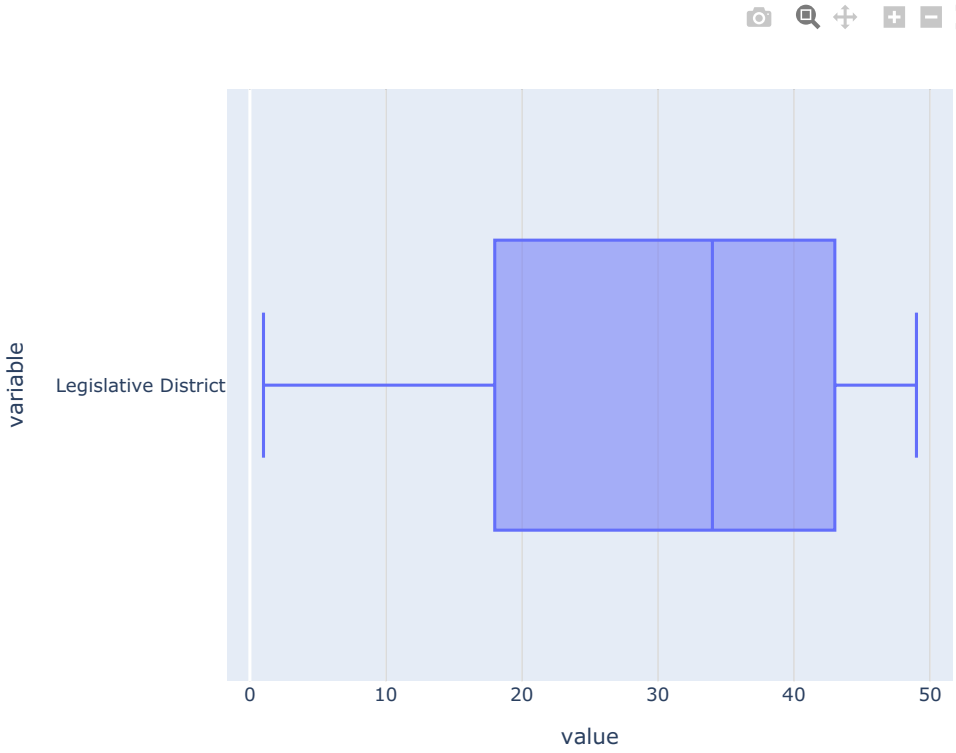
- numerical column - Legislative District
- categorical columns -Model, Vehicle Location,Electric Utility

In [10]:
```
df.describe()
```

Out[10]:

	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

In [11]:
```
#for numerical columns we have to check distributions for this we find outliers
px.box(df['Legislative District'],orientation='h')
```



To check the outliers by using IQR method(statistical_method)

In [12]:
```
q1=df['Legislative District'].quantile(0.25)

q3=df['Legislative District'].quantile(0.75)

iqr=q3-q1

lb=q1-1.5*iqr
ub=q1+1.5*iqr

df[(df['Legislative District']<=lb) | (df['Legislative District']>=ub)]
```

Out[12]:

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	Legislative District	DOL Vehicle ID	Vehicle Location	Elec Uti

Observation :

- Here also we can observe that there are no ouliers in our data.`

Fillling null values with mean.

In [13]:
```
df['Legislative District']=df['Legislative District'].fillna(df['Legislative District'].mean())
```

In [14]:
```
(df[df['Model'].isnull()])
```

Out[14]:

	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	Legisla Dis
13874	YV4ED3GM2P	King	Seattle	WA	98115	2023	VOLVO	NaN	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...	0	0	
30517	YV4ED3UL3P	King	Seattle	WA	98115	2023	VOLVO	NaN	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...	0	0	

31936	YV4ED3GM4P	Clallam	Sequim	WA	98382	2023	VOLVO	NaN	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...	0	0
37517	YV4ED3UW2P	Snohomish	Edmonds	WA	98026	2023	VOLVO	NaN	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...	0	0
58071	YV4ED3UM4P	King	Renton	WA	98058	2023	VOLVO	NaN	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...	0	0
61626	YV4ED3GM5P	Pierce	Tacoma	WA	98465	2023	VOLVO	NaN	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...	0	0
63240	YV4ED3GMXP	King	Redmond	WA	98052	2023	VOLVO	NaN	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...	0	0
63380	YV4ED3GM7P	King	Seattle	WA	98122	2023	VOLVO	NaN	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...	0	0
63462	YV4ED3UW4P	King	Newcastle	WA	98059	2023	VOLVO	NaN	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...	0	0
78472	YV4ED3UM1P	King	Fall City	WA	98024	2023	VOLVO	NaN	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...	0	0
81302	YV4ED3UM5P	King	Redmond	WA	98052	2023	VOLVO	NaN	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...	0	0
84142	YV4ED3UM2P	King	North Bend	WA	98045	2023	VOLVO	NaN	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...	0	0
86960	YV4ED3UM9P	King	Sammamish	WA	98075	2023	VOLVO	NaN	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...	0	0
88687	YV4ED3GM5P	King	Maple Valley	WA	98038	2023	VOLVO	NaN	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...	0	0
89882	YV4ED3UM5P	King	Bellevue	WA	98006	2023	VOLVO	NaN	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...	0	0
93197	YV4ED3GM8P	Snohomish	Bothell	WA	98021	2023	VOLVO	NaN	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...	0	0
103099	YV4ED3UW6P	Pierce	Milton	WA	98354	2023	VOLVO	NaN	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...	0	0
103394	YV4ED3GM5P	King	Seattle	WA	98133	2023	VOLVO	NaN	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...	0	0

108116	YV4ED3GL1P	King	Seattle	WA	98104	2023	VOLVO	NaN	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...	0	0				
112622	YV4ED3GM0P	King	Covington	WA	98042	2023	VOLVO	NaN	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...	0	0				

In [15]:
```
crosstab=pd.crosstab(df['Make'],df['Model'])
crosstab
```

Out[15]:

Make	Model	330E	500	530E	740E	745E	745LE	918	A3	A7	A8 E	...	TRANSIT CONNECT ELECTRIC	TUCSON	V60	VOLT	WRANGLER	X3
AUDI		0	0	0	0	0	0	0	575	11	3	...	0	0	0	0	0	0
AZURE DYNAMICS		0	0	0	0	0	0	0	0	0	0	...	7	0	0	0	0	0
BENTLEY		0	0	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0
BMW		303	0	323	30	7	2	0	0	0	0	...	0	0	0	0	0	292
CADILLAC		0	0	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0
CHEVROLET		0	0	0	0	0	0	0	0	0	0	...	0	0	0	4896	0	0
CHRYSLER		0	0	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0
FIAT		0	822	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0
FISKER		0	0	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0
FORD		0	0	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0
GENESIS		0	0	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0
HONDA		0	0	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0
HYUNDAI		0	0	0	0	0	0	0	0	0	0	...	0	38	0	0	0	0
JAGUAR		0	0	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0
JEEP		0	0	0	0	0	0	0	0	0	0	...	0	0	0	0	1104	0
KIA		0	0	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0
LAND ROVER		0	0	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0
LEXUS		0	0	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0
LINCOLN		0	0	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0
LUCID MOTORS		0	0	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0
MERCEDES-BENZ		0	0	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0
MINI		0	0	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0
MITSUBISHI		0	0	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0
NISSAN		0	0	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0
POLESTAR		0	0	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0
PORSCHE		0	0	0	0	0	0	1	0	0	0	...	0	0	0	0	0	0
RIVIAN		0	0	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0
SMART		0	0	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0
SUBARU		0	0	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0
TESLA		0	0	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0
TH!NK		0	0	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0
TOYOTA		0	0	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0
VOLKSWAGEN		0	0	0	0	0	0	0	0	0	0	...	0	0	0	0	0	0
VOLVO		0	0	0	0	0	0	0	0	0	0	...	0	0	12	0	0	0

34 rows × 114 columns

In [16]:
```
```

In [16]:
```
px.bar(crosstab,orientation='h',height=700)
```

In model we have missing values to fill these null values i choose condition based retrival

- only one Volvo brand having the null values so from volvo we fingd mode of model that is "XC90" now we use these value for null values.

In [17]:
```
df['Model']=df['Model'].fillna("XC90")
```

In [18]:
```
df['Model'].isnull().sum()
```

Out[18]:
```
0
```

In [19]:
```
df[df['Vehicle Location'].isnull()]
```

Out[19]:

	VIN (1-10)	County	City	State	Postal Code	Model Year	Make	Model	Electric Vehicle Type	Clean Alternative Fuel Vehicle (CAFV) Eligibility	Electric Range	Ba MSI
16	1N4AZ0CP4D	Pierce	Kapowsin	WA	98344	2013	NISSAN	LEAF	Battery Electric Vehicle (BEV)	Clean Alternative Fuel Vehicle Eligible	75	
9196	3FA6P0SU9E	Hidalgo	Mcallen	TX	78501	2014	FORD	FUSION	Plug-in Hybrid Electric Vehicle (PHEV)	Not eligible due to low battery range	19	
21728	5YJXCBE22G	Allegheny	Wexford	PA	15090	2016	TESLA	MODEL X	Battery Electric Vehicle (BEV)	Clean Alternative Fuel Vehicle Eligible	200	
26788	1N4BZ1CP7K	Pierce	Wilkeson	WA	98396	2019	NISSAN	LEAF	Battery Electric Vehicle	Clean Alternative Fuel	150	

									(BEV)	Vehicle Eligible		
29365	1G1FW6S08N	Pacific	Long Beach	WA	98634	2022	CHEVROLET	BOLT EV	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...	0	
46475	5YJ3E1EA8J	San Diego	Oceanside	CA	92051	2018	TESLA	MODEL 3	Battery Electric Vehicle (BEV)	Clean Alternative Fuel Vehicle Eligible	215	
61285	1FADP5CU5G	Thurston	Olympia	WA	98507	2016	FORD	C-MAX	Plug-in Hybrid Electric Vehicle (PHEV)	Not eligible due to low battery range	19	
64064	JN1AZ0CP6C	King	Seattle	WA	98124	2012	NISSAN	LEAF	Battery Electric Vehicle (BEV)	Clean Alternative Fuel Vehicle Eligible	73	
66278	1C4JJXR67M	Contra Costa	Fpo	CA	96349	2021	JEEP	WRANGLER	Plug-in Hybrid Electric Vehicle (PHEV)	Not eligible due to low battery range	21	
67925	JN1AZ0CP6C	King	Seattle	WA	98124	2012	NISSAN	LEAF	Battery Electric Vehicle (BEV)	Clean Alternative Fuel Vehicle Eligible	73	
76199	KNDJX3AE8H	Pacific	Long Beach	WA	98634	2017	KIA	SOUL EV	Battery Electric Vehicle (BEV)	Clean Alternative Fuel Vehicle Eligible	93	322
76894	1G1RH6E48C	Pierce	Tacoma	WA	98417	2012	CHEVROLET	VOLT	Plug-in Hybrid Electric Vehicle (PHEV)	Clean Alternative Fuel Vehicle Eligible	35	
78460	1FADP5CU9D	Kitsap	Southworth	WA	98386	2013	FORD	C-MAX	Plug-in Hybrid Electric Vehicle (PHEV)	Not eligible due to low battery range	19	
82086	JTDKARFP7H	Pierce	Wilkeson	WA	98396	2017	TOYOTA	PRIUS PRIME	Plug-in Hybrid Electric Vehicle (PHEV)	Not eligible due to low battery range	25	
88188	JTDKN3DP5E	Whatcom	Bellingham	WA	98227	2014	TOYOTA	PRIUS PLUG-IN	Plug-in Hybrid Electric Vehicle (PHEV)	Not eligible due to low battery range	6	
96588	3FA6P0PU2D	Pierce	Wilkeson	WA	98396	2013	FORD	FUSION	Plug-in Hybrid Electric Vehicle (PHEV)	Not eligible due to low battery range	19	
98398	5YJXCBE2XG	Thurston	Lacey	WA	98509	2016	TESLA	MODEL X	Battery Electric Vehicle (BEV)	Clean Alternative Fuel Vehicle Eligible	200	
101160	JN1AZ0CP0B	King	Seattle	WA	98124	2011	NISSAN	LEAF	Battery Electric Vehicle (BEV)	Clean Alternative Fuel Vehicle Eligible	73	
104056	5YJ3E1EC4L	Rockingham	Portsmouth	NH	3804	2020	TESLA	MODEL 3	Battery Electric Vehicle (BEV)	Clean Alternative Fuel Vehicle Eligible	308	
105210	1FADP5CU9D	Kitsap	Southworth	WA	98386	2013	FORD	C-MAX	Plug-in Hybrid Electric Vehicle	Not eligible due to low battery	19	

									(PHEV)	range	
106748	JN1AZ0CP1B	King	Seattle	WA	98124	2011	NISSAN	LEAF	Battery Electric Vehicle (BEV)	Clean Alternative Fuel Vehicle Eligible	73
108694	KM8K23AG6M	Pierce	Tacoma	WA	98401	2021	HYUNDAI	KONA ELECTRIC	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...	0
110547	1G1RD6E41D	Pierce	Tacoma	WA	98401	2013	CHEVROLET	VOLT	Plug-in Hybrid Electric Vehicle (PHEV)	Clean Alternative Fuel Vehicle Eligible	38
111234	3FMTK4SE6M	Pierce	Wilkeson	WA	98396	2021	FORD	MUSTANG MACH-E	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...	0

In [20]:
```
df['Electric Vehicle Type'].value_counts()
```

Out[20]:
```
Battery Electric Vehicle (BEV)            86044
Plug-in Hybrid Electric Vehicle (PHEV)    26590
Name: Electric Vehicle Type, dtype: int64
```

In [21]:
```
crosstab1=pd.crosstab(df['Vehicle Location'],df['Electric Vehicle Type'])
crosstab1['Battery Electric Vehicle (BEV)'].sort_values()
```

Out[21]:
```
Vehicle Location
POINT (7.86484 51.32975)          0
POINT (-118.01268 33.83899)       0
POINT (-121.92442 36.55443)       0
POINT (-117.97378 47.30036)       0
POINT (-117.90629 47.20139)       0
                                 ...
POINT (-122.21061 47.83448)    1538
POINT (-122.12096 47.55584)    1558
POINT (-122.1872 47.61001)     1718
POINT (-122.2066 47.67887)     1746
POINT (-122.13158 47.67858)    2485
Name: Battery Electric Vehicle (BEV), Length: 758, dtype: int64
```

In [22]:
```
crosstab1['Plug-in Hybrid Electric Vehicle (PHEV)'].sort_values()
```

Out[22]:
```
Vehicle Location
POINT (-102.69968 22.95716)      0
POINT (-76.8907 38.81605)        0
POINT (-118.50797 48.99237)      0
POINT (-118.59524 34.2271)       0
POINT (-76.73517 39.10852)       0
                               ...
POINT (-122.521 47.62728)      331
POINT (-122.35436 47.67596)    354
POINT (-122.31765 47.70013)    407
POINT (-122.89166 47.03956)    413
POINT (-122.13158 47.67858)    431
Name: Plug-in Hybrid Electric Vehicle (PHEV), Length: 758, dtype: int64
```

In [23]:
```
px.box(crosstab1)
```

In [24]:
```
df['Vehicle Location']=df['Vehicle Location'].fillna(df['Vehicle Location'].mode()[0])
```

In [25]:
```
df['Electric Utility']=df['Electric Utility'].fillna(df['Electric Utility'].mode()[0])
```

In [26]:
```
df.isnull().sum()
```

Out[26]:
```
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
```

outliers

In [27]:
```
df.columns
```

Out[27]:
```
Index(['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', 'Legislative District', 'DOL Vehicle ID',
       'Vehicle Location', 'Electric Utility', '2020 Census Tract'],
      dtype='object')
```

In [28]:
```
num=df.select_dtypes(include='number')
```

In [29]:
```
num
```

Out[29]:

	Postal Code	Model Year	Electric Range	Base MSRP	Legislative District	DOL Vehicle ID	2020 Census Tract
0	33040	2022	42	0	29.805604	198968248	12087972100
1	89029	2013	38	0	29.805604	5204412	32003005702
2	98901	2011	73	0	15.000000	218972519	53077001602
3	98237	2017	238	0	39.000000	186750406	53057951101
4	98201	2019	26	0	38.000000	2006714	53061041500
...	...	...	...	...	...	...	...
112629	98019	2022	0	0	45.000000	217955265	53033032401
112630	98250	2019	150	0	40.000000	103663227	53055960301
112631	98070	2022	38	0	34.000000	193878387	53033027702
112632	98042	2018	26	0	47.000000	125039043	53033032007
112633	98042	2022	18	0	47.000000	194673692	53033032005

112634 rows × 7 columns

In [30]:
```
px.box(df['Base MSRP'])
```

In [31]:
```
q1=df['Base MSRP'].quantile(0.25)

q3=df['Base MSRP'].quantile(0.75)

iqr=q3-q1

lb=q1-1.5*iqr
ub=q1+1.5*iqr

df[(df['Base MSRP']>=lb) & (df['Base MSRP']>=200000)]
```

Out[31]:

	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	Legislative District	V
62533	WP0CA2A13F	King	Hunts Point	WA	98004	2015	PORSCHE	918	Plug-in Hybrid Electric Vehicle (PHEV)	Not eligible due to low battery range	12	845000	48.0	1

In [32]:
```
df = df.drop(index=62533)
```

In [33]:
```
df.reset_index(drop='index',inplace=True)
```

In [34]:
```
df
```

Out[34]:

	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	L
0	JTMEB3FV6N	Monroe	Key West	FL	33040	2022	TOYOTA	RAV4 PRIME	Plug-in Hybrid Electric Vehicle (PHEV)	Clean Alternative Fuel Vehicle Eligible	42	0	2
1	1G1RD6E45D	Clark	Laughlin	NV	89029	2013	CHEVROLET	VOLT	Plug-in Hybrid Electric Vehicle (PHEV)	Clean Alternative Fuel Vehicle Eligible	38	0	2
2	JN1AZ0CP8B	Yakima	Yakima	WA	98901	2011	NISSAN	LEAF	Battery Electric Vehicle (BEV)	Clean Alternative Fuel Vehicle Eligible	73	0	1
3	1G1FW6S08H	Skagit	Concrete	WA	98237	2017	CHEVROLET	BOLT EV	Battery Electric Vehicle (BEV)	Clean Alternative Fuel Vehicle Eligible	238	0	3
4	3FA6P0SU1K	Snohomish	Everett	WA	98201	2019	FORD	FUSION	Plug-in Hybrid Electric Vehicle (PHEV)	Not eligible due to low battery range	26	0	3
...	...	...	...	...	...	...	...	...	...	...	...	...	
112628	7SAYGDEF2N	King	Duvall	WA	98019	2022	TESLA	MODEL Y	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...	0	0	4
112629	1N4BZ1CP7K	San Juan	Friday Harbor	WA	98250	2019	NISSAN	LEAF	Battery Electric Vehicle (BEV)	Clean Alternative Fuel Vehicle Eligible	150	0	4
112630	1FMCU0KZ4N	King	Vashon	WA	98070	2022	FORD	ESCAPE	Plug-in Hybrid Electric Vehicle (PHEV)	Clean Alternative Fuel Vehicle Eligible	38	0	3
112631	KNDCD3LD4J	King	Covington	WA	98042	2018	KIA	NIRO	Plug-in Hybrid Electric Vehicle (PHEV)	Not eligible due to low battery range	26	0	4
112632	YV4BR0CL8N	King	Covington	WA	98042	2022	VOLVO	XC90	Plug-in Hybrid Electric Vehicle (PHEV)	Not eligible due to low battery range	18	0	4

112633 rows × 17 columns

In [35]:
```
px.box(df['Base MSRP'])
```

Task1 (Description) - Apply Exploratory Data Analysis(Univariate and Bivariate) using plotly.express library.

In [36]:
```
fig=px.histogram(df['Model Year'],orientation='v',text_auto=True)
fig.show()
```

Observation

- Every year the frequency will be increased

In [37]:
```
cat=df.select_dtypes(exclude='number')
```

In [38]:
```
cat
```

Out[38]:

	VIN (1-10)	County	City	State	Make	Model	Electric Vehicle Type	Clean Alternative Fuel Vehicle (CAFV) Eligibility	Vehicle Location	Electric Ut
0	JTMEB3FV6N	Monroe	Key West	FL	TOYOTA	RAV4 PRIME	Plug-in Hybrid Electric Vehicle (PHEV)	Clean Alternative Fuel Vehicle Eligible	POINT (-81.80023 24.5545)	PUGET SOUND ENEI INC||CITY OF TACOI (
1	1G1RD6E45D	Clark	Laughlin	NV	CHEVROLET	VOLT	Plug-in Hybrid Electric Vehicle (PHEV)	Clean Alternative Fuel Vehicle Eligible	POINT (-114.57245 35.16815)	PUGET SOUND ENEI INC||CITY OF TACOI (
2	JN1AZ0CP8B	Yakima	Yakima	WA	NISSAN	LEAF	Battery Electric Vehicle (BEV)	Clean Alternative Fuel Vehicle Eligible	POINT (-120.50721 46.60448)	PACIFIC(
3	1G1FW6S08H	Skagit	Concrete	WA	CHEVROLET	BOLT EV	Battery Electric Vehicle (BEV)	Clean Alternative Fuel Vehicle Eligible	POINT (-121.7515 48.53892)	PUGET SOUND ENEI
4	3FA6P0SU1K	Snohomish	Everett	WA	FORD	FUSION	Plug-in Hybrid Electric Vehicle (PHEV)	Not eligible due to low battery range	POINT (-122.20596 47.97659)	PUGET SOUND ENEI
...	...	...	...	...	...	...	...	...	...	
112628	7SAYGDEF2N	King	Duvall	WA	TESLA	MODEL Y	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...	POINT (-121.98609 47.74068)	PUGET SOUND ENEI INC||CITY OF TACOI (
112629	1N4BZ1CP7K	San Juan	Friday Harbor	WA	NISSAN	LEAF	Battery Electric Vehicle (BEV)	Clean Alternative Fuel Vehicle Eligible	POINT (-123.01648 48.53448)	BONNEVILLE POV ADMINISTRATION||OR(POWER
112630	1FMCU0KZ4N	King	Vashon	WA	FORD	ESCAPE	Plug-in Hybrid Electric Vehicle (PHEV)	Clean Alternative Fuel Vehicle Eligible	POINT (-122.4573 47.44929)	PUGET SOUND ENEI INC||CITY OF TACOI (
112631	KNDCD3LD4J	King	Covington	WA	KIA	NIRO	Plug-in Hybrid Electric Vehicle (PHEV)	Not eligible due to low battery range	POINT (-122.09124 47.33778)	PUGET SOUND ENEI INC||CITY OF TACOI (
112632	YV4BR0CL8N	King	Covington	WA	VOLVO	XC90	Plug-in Hybrid Electric Vehicle (PHEV)	Not eligible due to low battery range	POINT (-122.09124 47.33778)	PUGET SOUND ENEI INC||CITY OF TACOI (

112633 rows × 10 columns

In [39]:
```
px.bar(df['County'][0:50],title='Top 50 countries')
```

In [40]:
```
px.bar(df['Make'][0:1000])
```

Observation:

- TESLA having more intrested to manufacturing the electronic vehicle

In [41]:
```
px.bar(df['Electric Vehicle Type'][0:500])
```

Observation:

- Most of the companies are using Battery ELectric Vehicles comparing witj plug-in-Hybrid electric vehicle

BI-VARIATE

In [42]:
```
px.scatter(x=df['Electric Range'],y=df['Base MSRP'],data_frame=df)
```

In [43]:
```
px.scatter(x=df['Model Year'],y=df['Electric Range'],data_frame=df)
```

Observation:

- In the Model Year 2020 having the high electric range that is 337 compare to the other model years

In [44]:
```
px.box(x='Make',y='Electric Range',data_frame=df)
```

Observation

- Tesla having the maximum electric range that is 337.

In [45]:
```
px.box(x=df['Make'],y=df['Base MSRP'],data_frame=df)
```

In [46]:
```
px.box(x=df['Make'],y=df['Model Year'],data_frame=df)
```

Observation:

- KIA And Tesla most of average electrical vehicles released in 2021 model-year becuase the median is 2021

In [47]:
```
px.box(x=df['Electric Vehicle Type'],y=df['Electric Range'],data_frame=df)
```

Observation:

- Battery Electric Vehicle have more electric range that is 337

In [48]:
```
cat
```

Out[48]:

	VIN (1-10)	County	City	State	Make	Model	Electric Vehicle Type	Clean Alternative Fuel Vehicle (CAFV) Eligibility	Vehicle Location	Electric Ut
0	JTMEB3FV6N	Monroe	Key West	FL	TOYOTA	RAV4 PRIME	Plug-in Hybrid Electric Vehicle (PHEV)	Clean Alternative Fuel Vehicle Eligible	POINT (-81.80023 24.5545)	PUGET SOUND ENEI INC||CITY OF TACOI (
1	1G1RD6E45D	Clark	Laughlin	NV	CHEVROLET	VOLT	Plug-in Hybrid Electric Vehicle (PHEV)	Clean Alternative Fuel Vehicle Eligible	POINT (-114.57245 35.16815)	PUGET SOUND ENEI INC||CITY OF TACOI (
2	JN1AZ0CP8B	Yakima	Yakima	WA	NISSAN	LEAF	Battery Electric Vehicle (BEV)	Clean Alternative Fuel Vehicle Eligible	POINT (-120.50721 46.60448)	PACIFIC(
3	1G1FW6S08H	Skagit	Concrete	WA	CHEVROLET	BOLT EV	Battery Electric Vehicle (BEV)	Clean Alternative Fuel Vehicle Eligible	POINT (-121.7515 48.53892)	PUGET SOUND ENEI
4	3FA6P0SU1K	Snohomish	Everett	WA	FORD	FUSION	Plug-in Hybrid Electric Vehicle (PHEV)	Not eligible due to low battery range	POINT (-122.20596 47.97659)	PUGET SOUND ENEI
...	...	...	...	...	...	...	...	...	...	
112628	7SAYGDEF2N	King	Duvall	WA	TESLA	MODEL Y	Battery Electric Vehicle (BEV)	Eligibility unknown as battery range has not b...	POINT (-121.98609 47.74068)	PUGET SOUND ENEI INC||CITY OF TACOI (
112629	1N4BZ1CP7K	San Juan	Friday Harbor	WA	NISSAN	LEAF	Battery Electric Vehicle (BEV)	Clean Alternative Fuel Vehicle Eligible	POINT (-123.01648 48.53448)	BONNEVILLE POW ADMINISTRATION||OR(POWER
112630	1FMCU0KZ4N	King	Vashon	WA	FORD	ESCAPE	Plug-in Hybrid Electric Vehicle (PHEV)	Clean Alternative Fuel Vehicle Eligible	POINT (-122.4573 47.44929)	PUGET SOUND ENEI INC||CITY OF TACOI (
112631	KNDCD3LD4J	King	Covington	WA	KIA	NIRO	Plug-in Hybrid Electric Vehicle (PHEV)	Not eligible due to low battery range	POINT (-122.09124 47.33778)	PUGET SOUND ENEI INC||CITY OF TACOI (
112632	YV4BR0CL8N	King	Covington	WA	VOLVO	XC90	Plug-in Hybrid Electric Vehicle (PHEV)	Not eligible due to low battery range	POINT (-122.09124 47.33778)	PUGET SOUND ENEI INC||CITY OF TACOI (

112633 rows × 10 columns

In [49]:
```
crosstab_1=pd.crosstab(df['Make'],df['Model'])
px.bar(crosstab_1,orientation='h',height=700)
```

Observation:

- BMW making more model electric vehicle's like x5,x3,1x,I8,I4,I3,740E,530E,330E.

statistical test

Is there a relationship between Make and Country (i.e. Does the preference ofCountry depend on the Making company?)

h0:Make and Country has relationship

h1:Make and Country has no relationship

In [50]:
```
from scipy.stats import chi2_contingency
from scipy.stats import chi2
```

In [51]:
```
observed = pd.crosstab(df.Make,df.County)
```

In [52]:
```
chi2_contingency(observed)
```

Out[52]:
```
Chi2ContingencyResult(statistic=17206.387705438785, pvalue=0.0, dof=5412, expected_freq=array([[7.24654409e-01,
4.14088233e-02, 1.65635293e-01, ...,
        4.14088233e-02, 2.07044117e-02, 1.27746220e+01],
       [2.17520620e-03, 1.24297497e-04, 4.97189989e-04, ...,
        1.24297497e-04, 6.21487486e-05, 3.83457779e-02],
       [9.32231229e-04, 5.32703559e-05, 2.13081424e-04, ...,
        5.32703559e-05, 2.66351780e-05, 1.64339048e-02],
       ...,
       [1.36882619e+00, 7.82186393e-02, 3.12874557e-01, ...,
        7.82186393e-02, 3.91093196e-02, 2.41304502e+01],
       [7.81209770e-01, 4.46405583e-02, 1.78562233e-01, ...,
        4.46405583e-02, 2.23202791e-02, 1.37716122e+01],
       [7.10981684e-01, 4.06275248e-02, 1.62510099e-01, ...,
        4.06275248e-02, 2.03137624e-02, 1.25335914e+01]]))
```

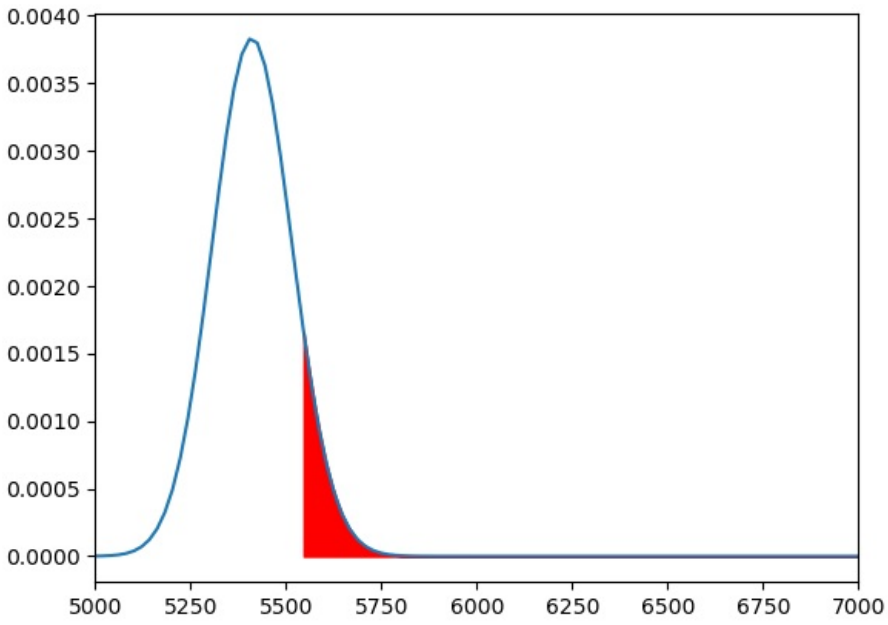
In [53]:
```
chi2_test_stat = chi2_contingency(observed)[0]
pval = chi2_contingency(observed)[1]
df = chi2_contingency(observed)[2]
```

In [54]:
```
confidence_level = 0.90

alpha = 1 - confidence_level

chi2_critical = chi2.ppf(1 - alpha, df)

chi2_critical
```

Out[54]: 5545.751557653358

In [55]:
```
# Ploting the chi2 distribution to visualise

# Defining the x minimum and x maximum
#plt.figure(figsize=(15,6))
x_min = 5000
x_max = 7000

# Ploting the graph and setting the x limits
x = np.linspace(x_min, x_max, 100)
y = chi2.pdf(x, df)
plt.xlim(x_min, x_max)
plt.plot(x, y)


# Setting Chi2 Critical value
chi2_critical_right = chi2_critical

# Shading the right rejection region
x1 = np.linspace(chi2_critical_right, x_max, 100)
y1 = chi2.pdf(x1, df)
plt.fill_between(x1, y1, color='red')
```

Out[55]: <matplotlib.collections.PolyCollection at 0x1cc0107a650>



In [56]:
```
if(chi2_test_stat > chi2_critical):
    print("Reject Null Hypothesis")
else:
    print("Fail to Reject Null Hypothesis")
```

Reject Null Hypothesis

In [57]:
```
if(pval < alpha):
    print("Reject Null Hypothesis")
else:
    print("Fail to Reject Null Hypothesis")
```

Reject Null Hypothesis

In [60]:
```
crosstab_2=pd.crosstab(df['Make'],df['County'])
px.bar(crosstab_2,orientation='h',height=700)
```

Observation:

- In king country having every type of company electrical vehicle so we can say that the electric vehicle buisness most popular in KING country

Conclusion:¶

- Since the p-value is less than the significance level of 0.05, we can reject the null hypothesis. Therefore, we can conclude that there is a no relationship between Make and country.

Task2 (Description) - Create a Choropleth to display the number of EV vehicles based on location.

In [61]:
```
import plotly.graph_objects as go
def create_ev_choropleth_map(df):
    # Calculate the count of EV vehicles for each state
    ev_count_by_state = df['State'].value_counts().reset_index()
    ev_count_by_state.columns = ['State', 'EV Count']

    # Create the Choropleth map using plotly.graph_objects
    fig_choropleth = go.Figure(data=go.Choropleth(
        locations=ev_count_by_state['State'],
        z=ev_count_by_state['EV Count'],
        locationmode='USA-states',
        colorscale='Viridis',
        colorbar_title='Number of EV Vehicles',
    ))

    # Set the map title and layout
    fig_choropleth.update_layout(
        title_text='Choropleth Map of EV Vehicles by State',
        geo_scope='world',
    )
```

```
    return fig_choropleth

fig = create_ev_choropleth_map(df)
fig.show()
```

Task3 (Description) - Create a Racing Bar Plot to display the animation of EV Make and its count each year.

In [73]:
```
pip install bar_chart_race
```

```
Collecting bar_chart_race
  Downloading bar_chart_race-0.1.0-py3-none-any.whl (156 kB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 156.8/156.8 kB 4.2 MB/s eta 0:00:00
Requirement already satisfied: pandas>=0.24 in /usr/local/lib/python3.10/dist-packages (from bar_chart_race) (1.
5.3)
Requirement already satisfied: matplotlib>=3.1 in /usr/local/lib/python3.10/dist-packages (from bar_chart_race)
(3.7.1)
Requirement already satisfied: contourpy>=1.0.1 in /usr/local/lib/python3.10/dist-packages (from matplotlib>=3.1
->bar_chart_race) (1.1.0)
Requirement already satisfied: cycler>=0.10 in /usr/local/lib/python3.10/dist-packages (from matplotlib>=3.1->ba
r_chart_race) (0.11.0)
Requirement already satisfied: fonttools>=4.22.0 in /usr/local/lib/python3.10/dist-packages (from matplotlib>=3.
1->bar_chart_race) (4.41.0)
Requirement already satisfied: kiwisolver>=1.0.1 in /usr/local/lib/python3.10/dist-packages (from matplotlib>=3.
1->bar_chart_race) (1.4.4)
Requirement already satisfied: numpy>=1.20 in /usr/local/lib/python3.10/dist-packages (from matplotlib>=3.1->bar
_chart_race) (1.22.4)
Requirement already satisfied: packaging>=20.0 in /usr/local/lib/python3.10/dist-packages (from matplotlib>=3.1-
>bar_chart_race) (23.1)
Requirement already satisfied: pillow>=6.2.0 in /usr/local/lib/python3.10/dist-packages (from matplotlib>=3.1->b
ar_chart_race) (8.4.0)
Requirement already satisfied: pyparsing>=2.3.1 in /usr/local/lib/python3.10/dist-packages (from matplotlib>=3.1
->bar_chart_race) (3.1.0)
Requirement already satisfied: python-dateutil>=2.7 in /usr/local/lib/python3.10/dist-packages (from matplotlib>
=3.1->bar_chart_race) (2.8.2)
Requirement already satisfied: pytz>=2020.1 in /usr/local/lib/python3.10/dist-packages (from pandas>=0.24->bar_c
hart_race) (2022.7.1)
Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.10/dist-packages (from python-dateutil>=2.7->m
atplotlib>=3.1->bar_chart_race) (1.16.0)
Installing collected packages: bar_chart_race
Successfully installed bar_chart_race-0.1.0
```

In [74]:
```
import bar_chart_race as bcr
```

In [75]:
```
# Converting the 'Model Year' column to datetime type
df['Model Year'] = pd.to_datetime(df['Model Year'], format='%Y')

# Group by 'Model Year' and 'Make' to get the count of each make for each year
```

```
df_grouped = df.groupby(['Model Year', 'Make']).size().reset_index(name='Count')



import bar_chart_race as bcr

df_pivot = df_grouped.pivot(index='Model Year', columns='Make', values='Count')

# Fill missing values using forward fill (pad)
df_pivot = df_pivot.fillna(method='pad')

# Create the Racing Bar Plot
bcr.bar_chart_race(
    df=df_pivot,
    filename='ev_make_racing_bar_plot.mp4',
    orientation='h',
    sort='desc',
    n_bars=10,
    fixed_order=False,
    title='EV Make Racing Bar Plot by Year',
    label_bars=True,
    period_label={'x': 0.99, 'y': 0.25, 'ha': 'right', 'va': 'center'},
)
```

Conclusion

- Every year the frequency will be increased
- BMW making more model electric vehicle's like x5,x3,1x,I8,I4,I3,740E,530E,330E.
- Tesla having the maximum electric range that is 337.
- In the Model Year 2020 having the high electric range that is 337 compare to the other model years.
- Most of the companies are using Battery ELectric Vehicles comparing witj plug-in-Hybrid electric vehicle.
- Seattle is the top city in top 10 with electric Cars.
- King County is the top in top 10 county with more electric Vehicles
- 98052 postal code contains the high electric cars.
- JAGUR have the more electric range comapre to other makes.
- Tesla is the most popular electric car make in Washington state, followed by Nissan, Chevrolet, and Toyota.
- Tesla is also the most popular make in Seattle, followed by Nissan, Chevrolet, and BMW.
- Washington state has the highest number of Audi, BMW, and Chevrolet electric cars registered among all states.

In [ ]: