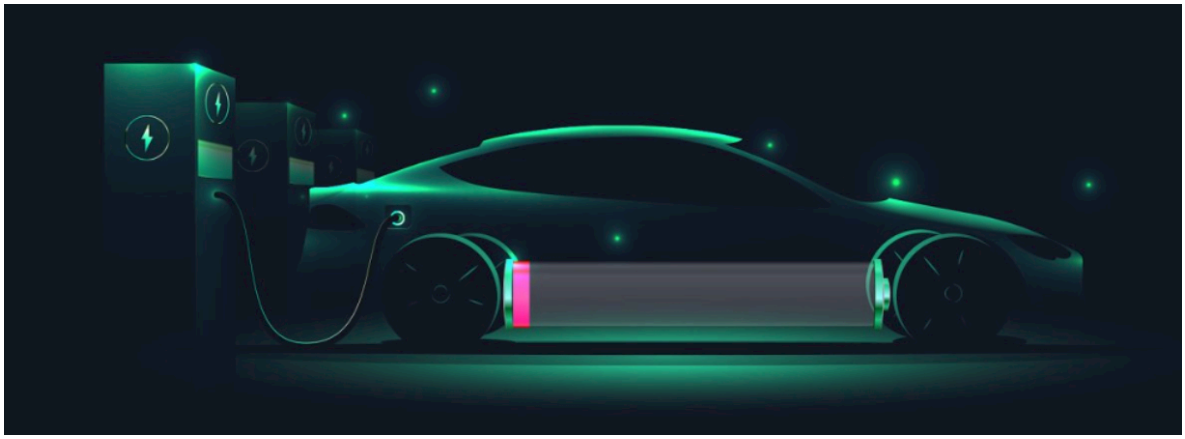
ELECTRIC CAR SALES (DESIGNING TRAIN, TEST & SPLIT)

09:04:2023



Hemant Thapa

Electric cars have become increasingly popular in recent years due to their numerous benefits over traditional gasoline vehicles. One of the biggest benefits is their low operating costs, as electricity is much cheaper than gasoline and EVs have fewer moving parts that require maintenance. Additionally, electric cars emit no tailpipe pollutants, making them a much cleaner and environmentally-friendly mode of transportation.

Another advantage of electric cars is their performance. Many electric cars have instant torque, meaning that they have strong acceleration right from the start. This is because electric motors deliver maximum torque from a standstill, while internal combustion engines require time to build up power. Additionally, electric cars are often much quieter than gasoline cars, as they produce very little noise.

There are also various charging options available for electric cars, including fast charging networks, home charging stations, and public charging stations. This means that drivers can easily recharge their cars at convenient locations, whether they're at home, work, or on the road.

In [1]:
```
import pandas as pd
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt
import matplotlib_inline
import missingno as msno
import warnings
warnings.filterwarnings("ignore")
import datetime
import time
```

DESIGNING LINEAR REGRESSION MODEL

In [2]:
```python
import numpy as np

class LineModel:
    def __init__(self, x, y):
        self.x = x
        self.y = y
        self.b1, self.bo = self.LinearRegression()

    def LinearRegression(self):
        x_mean = self.x.mean()
        y_mean = self.y.mean()
        x_value = self.x - x_mean
        y_value = self.y - y_mean
        x_value_square = np.square(x_value)
        x_value_square_total = x_value_square.sum()
        x_y_value_square = np.multiply(x_value, y_value)
        x_y_value_square_total = x_y_value_square.sum()
        b1 = x_y_value_square_total / x_value_square_total
        bo = y_mean - (b1 * x_mean)
        return b1, bo

    def predict(self, x_test):
        y_pred = self.b1 * x_test + self.bo
        return y_pred
```

DESIGNING TRAIN TEST AND SPLIT

In [3]:
```python
class TrainTestSplit:
    def __init__(self, X, y, test_size=0.2):
        self.X = X
        self.y = y
        self.test_size = test_size

    def split(self):
        np.random.seed(0)
        indices = np.random.permutation(self.X.shape[0])
        split = int(self.X.shape[0] * (1-self.test_size))
        train_indices = indices[:split]
        test_indices = indices[split:]
        X_train, y_train = self.X[train_indices], self.y[train_indices]
        X_test, y_test = self.X[test_indices], self.y[test_indices]
        return X_train, X_test, y_train, y_test
```

CLASS STOCK

In [4]:
```python
import yfinance as yf

class Stock:
    def __init__(self, ticker):
        self.ticker = ticker
    def Price(self, ticker):
        stock = yf.Ticker(self.ticker).history(period="max")
        return stock
```

In this report we will check top selling one year electric car chart and perform trend analysis.

In [5]:
```
days = 365 #365days
```

In [189…
```
#from yahoo finance Api, we only able to mine these data
tesla_stock = Stock("TSLA").Price("TSLA").tail(days)
general_motor_stock = Stock("GM").Price("GM").tail(days)
ford_stock = Stock("F").Price("F").tail(days)
```

In [7]:
```
snp500 = Stock("^GSPC").Price("^GSPC").tail(days)
```

In [214…
```
top500 = pd.read_excel("snp500.xlsx")
top500[:5]
```

Out[214]:

	serial_number	company	ticker	weight	price	change	percent change
0	1	Apple Inc.	AAPL	7.136544	164.55	-0.11	(-0.07%)
1	2	Microsoft Corporation	MSFT	6.325500	291.72	0.12	-0.0004
2	3	Amazon.com Inc.	AMZN	2.651518	101.91	-0.15	(-0.15%)
3	4	NVIDIA Corporation	NVDA	1.938229	270.58	0.21	-0.0008
4	5	Alphabet Inc. Class A	GOOGL	1.881812	108.28	-0.14	(-0.13%)

In [219…
```
sorted_companies = top500.company.unique()
sorted_companies.sort()
sorted_companies[:25]
```

Out[219]:
```
array(['3M Company', 'A. O. Smith Corporation', 'AES Corporation',
       'AMETEK Inc.', 'ANSYS Inc.', 'APA Corporation', 'AT&T Inc.',
       'AbbVie Inc.', 'Abbott Laboratories', 'Accenture Plc Class A',
       'Activision Blizzard Inc.', 'Adobe Incorporated',
       'Advance Auto Parts Inc.', 'Advanced Micro Devices Inc.',
       'Aflac Incorporated', 'Agilent Technologies Inc.',
       'Air Products and Chemicals Inc.', 'Akamai Technologies Inc.',
       'Alaska Air Group Inc.', 'Albemarle Corporation',
       'Alexandria Real Estate Equities Inc.', 'Align Technology Inc.',
       'Allegion Public Limited Company', 'Alliant Energy Corp',
       'Allstate Corporation'], dtype=object)
```

1. LOADING DATASET

In [8]:
```
df = pd.read_csv('Electric_Vehicle_Population_Data.csv')
```

2. CHECKING NULL VALUES

In [9]:
```
df.isnull().sum()
```

Out[9]:
```
VIN (1-10)                                             0
County                                                 0
City                                                   0
State                                                  0
Postal Code                                            0
Model Year                                             0
Make                                                   0
Model                                                  4
Electric Vehicle Type                                  0
Clean Alternative Fuel Vehicle (CAFV) Eligibility      0
Electric Range                                         0
Base MSRP                                              0
Legislative District                                 284
DOL Vehicle ID                                         0
Vehicle Location                                    3508
Electric Utility                                     431
2020 Census Tract                                      0
dtype: int64
```

3. CONVERTING COLUMNS TO SNAKE CASE

In [10]:
```
df.columns = df.columns.str.lower()
df.columns = df.columns.str.replace(" ", "_")
```

In [11]:
```
df.columns
```

Out[11]:
```
Index(['vin_(1-10)', 'county', 'city', 'state', 'postal_code', 'model_yea
r',
       'make', 'model', 'electric_vehicle_type',
       'clean_alternative_fuel_vehicle_(cafv)_eligibility', 'electric_ran
ge',
       'base_msrp', 'legislative_district', 'dol_vehicle_id',
       'vehicle_location', 'electric_utility', '2020_census_tract'],
      dtype='object')
```

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

Out[12]:
```
vin_(1-10)                                             0
county                                                 0
city                                                   0
state                                                  0
postal_code                                            0
model_year                                             0
make                                                   0
model                                                  4
electric_vehicle_type                                  0
clean_alternative_fuel_vehicle_(cafv)_eligibility      0
electric_range                                         0
base_msrp                                              0
legislative_district                                 284
dol_vehicle_id                                         0
vehicle_location                                    3508
electric_utility                                     431
2020_census_tract                                      0
dtype: int64
```

In [13]:
```
df['vin_(1-10)'].unique()
```

Out[13]:
```
array(['1N4BZ0CP9G', '1N4AZ0CP5G', '1N4BZ1CP7K', ..., 'YV4102CK7K',
       'WA1LABGE5M', 'YV4BR0CL8L'], dtype=object)
```

In [14]:
```
# Drop the "electric_utility" column
df = df.drop(columns=['vin_(1-10)'])
```

In [15]:
```
df = df.rename(columns={"clean_alternative_fuel_vehicle_(cafv)_eligibilit
```

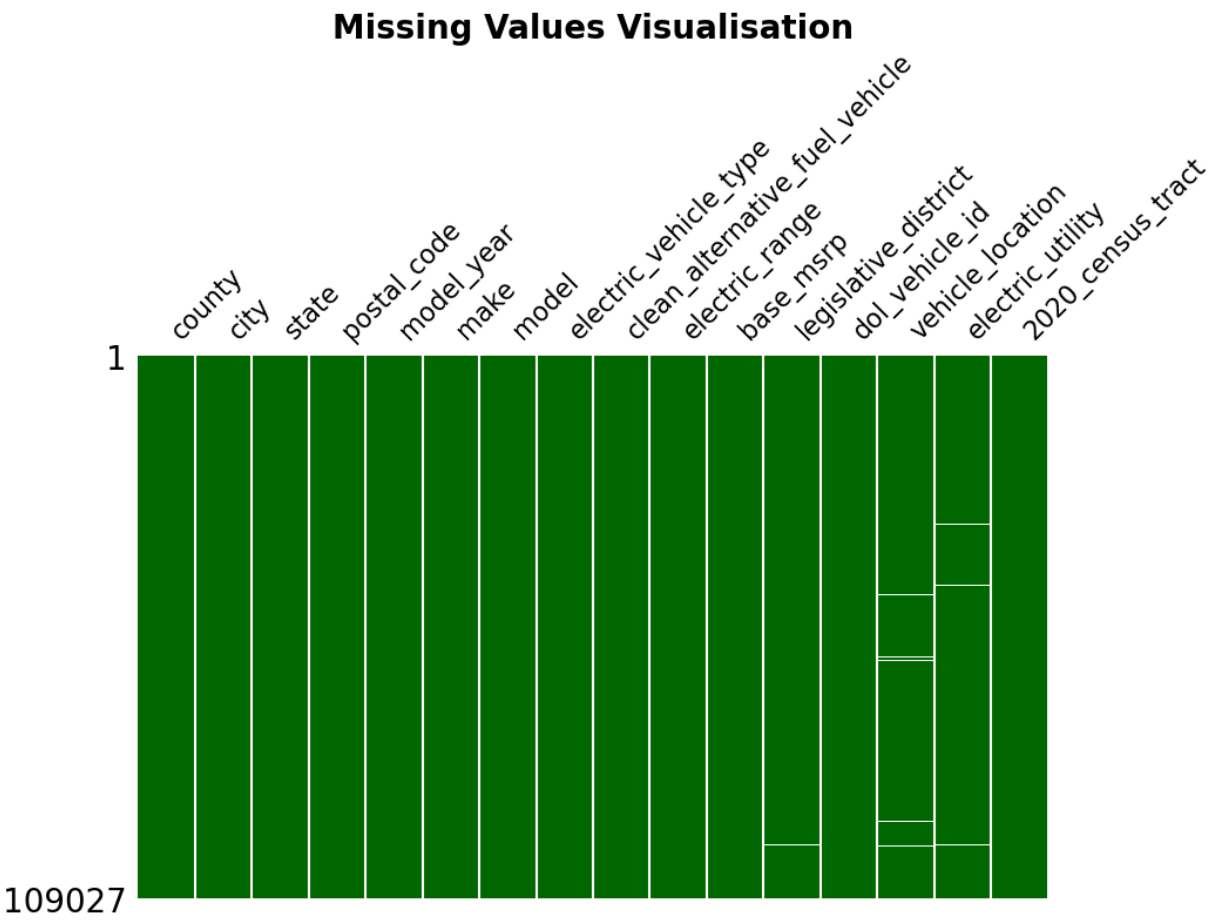
In [16]:
```
df[:5]
```

Out[16]:

	county	city	state	postal_code	model_year	make	model	electric_vehicl
0	Snohomish	Arlington	WA	98223	2016	NISSAN	LEAF	Battery Vehicl
1	King	Seattle	WA	98118	2016	NISSAN	LEAF	Battery Vehicl
2	Thurston	Olympia	WA	98502	2019	NISSAN	LEAF	Battery Vehicl
3	Frederick	Frederick	MD	21704	2019	TESLA	MODEL 3	Battery Vehicl
4	King	Bellevue	WA	98008	2020	TESLA	MODEL 3	Battery Vehicl

4. VISUALISATION OF MISSING VALUES

In [17]:
```
fig, ax = plt.subplots(figsize=(10, 6))
msno.matrix(df, color=(0, 0.4, 0), labels=True, ax=ax)
plt.title('Missing Values Visualisation', fontsize=20, fontweight='bold')
plt.show()
```



5. IMPUTATION OF MISSING NUMERICAL VALUES

In [18]:
```
from sklearn.experimental import enable_iterative_imputer
from sklearn.impute import IterativeImputer
from sklearn.ensemble import RandomForestRegressor
```

In [19]:
```
# Create an instance of IterativeImputer with a RandomForestRegressor est
imputer = IterativeImputer(estimator=RandomForestRegressor(), max_iter=10
```

In [20]:
```
# Fit the imputer to the data
imputer.fit(df[['legislative_district']])
```

Out[20]:

▸ **IterativeImputer**

▸ **estimator: RandomForestRegressor**

▸ RandomForestRegressor

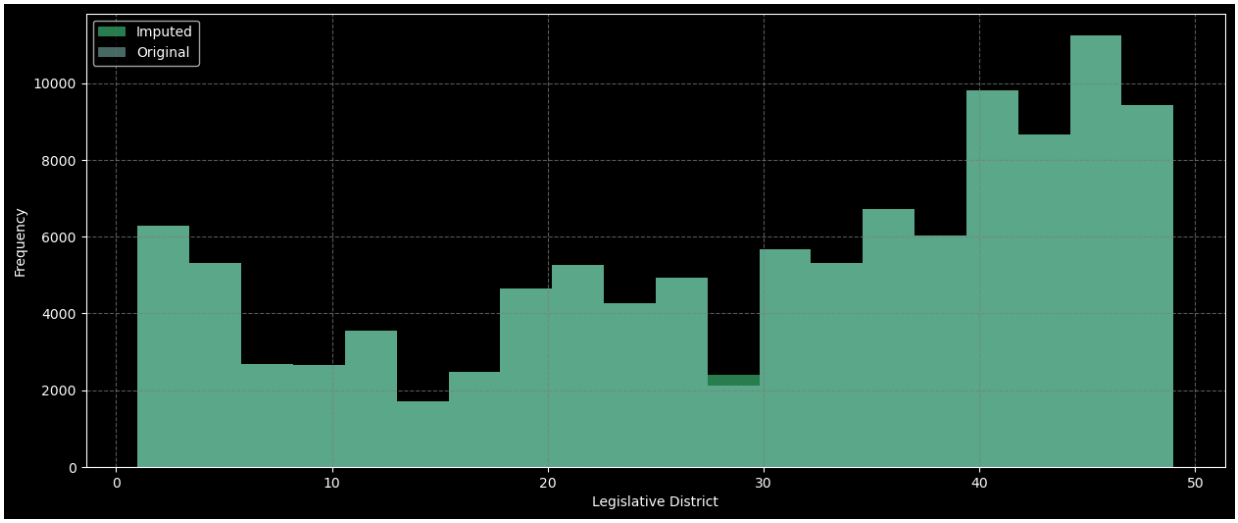
In [21]:
```
# Transform the data
data_imputed = imputer.transform(df[['legislative_district']])
```

In [22]:
```
df.isnull().sum()
```

Out[22]:
```
county                                0
city                                  0
state                                 0
postal_code                           0
model_year                            0
make                                  0
model                                 4
electric_vehicle_type                 0
clean_alternative_fuel_vehicle        0
electric_range                        0
base_msrp                             0
legislative_district                284
dol_vehicle_id                        0
vehicle_location                   3508
electric_utility                    431
2020_census_tract                     0
dtype: int64
```

6. VISUALISATION OF IMPUTATION

In [23]:
```
plt.style.use('dark_background')
plt.figure(figsize=(15,6))
plt.hist(data_imputed, bins=20, alpha=0.9, label='Imputed', color="seagre
plt.hist(df['legislative_district'], bins=20, alpha=0.5, label='Original'
plt.legend()
plt.xlabel('Legislative District')
plt.ylabel('Frequency')
plt.grid(linestyle='--', color='gray', alpha=0.7)
plt.show()
```



In [24]:
```
df['legislative_district'] = data_imputed
```

In [25]:
```
df.legislative_district.isnull().sum()
```

Out[25]:
```
0
```

In [26]:
```
# Drop the "vehicle_location" column
df = df.drop(columns=['vehicle_location'])
```

In [27]:
```
# Drop the "electric_utility" column
df = df.drop(columns=['electric_utility'])
```

In [28]:
```
# Remove rows with NaN values
df = df.dropna()
```

In [29]:
```
df.isnull().sum()
```

Out[29]:
```
county                             0
city                               0
state                              0
postal_code                        0
model_year                         0
make                               0
model                              0
electric_vehicle_type              0
clean_alternative_fuel_vehicle     0
electric_range                     0
base_msrp                          0
legislative_district               0
dol_vehicle_id                     0
2020_census_tract                  0
dtype: int64
```

In [30]:
```
counties = sorted(df.county.unique())
print(counties)
```

```
['Adams', 'Alameda', 'Alexandria', 'Allegheny', 'Anchorage', 'Anne Arunde
l', 'Arapahoe', 'Asotin', 'Bartow', 'Bell', 'Benton', 'Bexar', 'Boulder',
'Bryan', 'Burlington', 'Calvert', 'Camden', 'Carroll', 'Charles', 'Charle
ston', 'Chaves', 'Chelan', 'Chesapeake', 'Clackamas', 'Clallam', 'Clark',
'Columbia', 'Contra Costa', 'Cook', 'Coryell', 'Cowlitz', 'Cumberland', '
Danville', 'DeKalb', 'Denton', 'District of Columbia', 'Douglas', 'Duval'
, 'El Paso', 'Fairbanks North Star', 'Fairfax', 'Ferry', 'Franklin', 'Fre
derick', 'Galveston', 'Garfield', 'Geary', 'Grant', 'Grays Harbor', 'Hami
lton', 'Harris', 'Harrison', 'Hidalgo', 'Hillsborough', 'Hoke', 'Honolulu
', 'Houston', 'Howard', 'Hudson', 'Island', 'Jackson', 'Jefferson', 'June
au', 'Kent', 'Kern', 'King', 'Kings', 'Kitsap', 'Kittitas', 'Klickitat',
'Kootenai', 'Lake', 'Laramie', 'Larimer', 'Las Animas', 'Leavenworth', 'L
ewis', 'Lincoln', 'Los Angeles', 'Loudoun', 'Louisa', 'Manassas', 'Marico
pa', 'Marin', 'Mason', 'Mecklenburg', 'Middlesex', 'Monroe', 'Monterey',
'Montgomery', 'Moore', 'Multnomah', 'Napa', 'New Castle', 'New London', '
Newport', 'Norfolk', 'Nueces', 'Okaloosa', 'Okanogan', 'Oldham', 'Onslow'
, 'Orange', 'Ozaukee', 'Pacific', 'Palm Beach', 'Pend Oreille', 'Penningt
on', 'Penobscot', 'Philadelphia', 'Pierce', 'Pinal', 'Placer', 'Plaquemin
es', 'Platte', 'Polk', 'Portsmouth', "Prince George's", 'Prince William',
'Pulaski', 'Queens', 'Ray', 'Riverside', 'Rock Island', 'Rockdale', 'Sacr
amento', 'Salt Lake', 'San Bernardino', 'San Diego', 'San Juan', 'Santa B
arbara', 'Santa Clara', 'Santa Cruz', 'Sarasota', 'Saratoga', 'Sarpy', 'S
heridan', 'Skagit', 'Skamania', 'Snohomish', 'Solano', 'Sonoma', 'Spartan
burg', 'Spokane', 'St. Clair', 'St. Louis', "St. Mary's", 'Stafford', 'St
evens', 'Suffolk', 'Sumter', 'Tarrant', 'Thurston', 'Tipton', 'Ventura',
'Virginia Beach', 'Wahkiakum', 'Walla Walla', 'Washington', 'Wayne', 'Wha
tcom', 'Whitman', 'Wichita', 'Williams', 'Yakima']
```

In [31]:
```
df.shape
```

Out[31]:
```
(109023, 14)
```

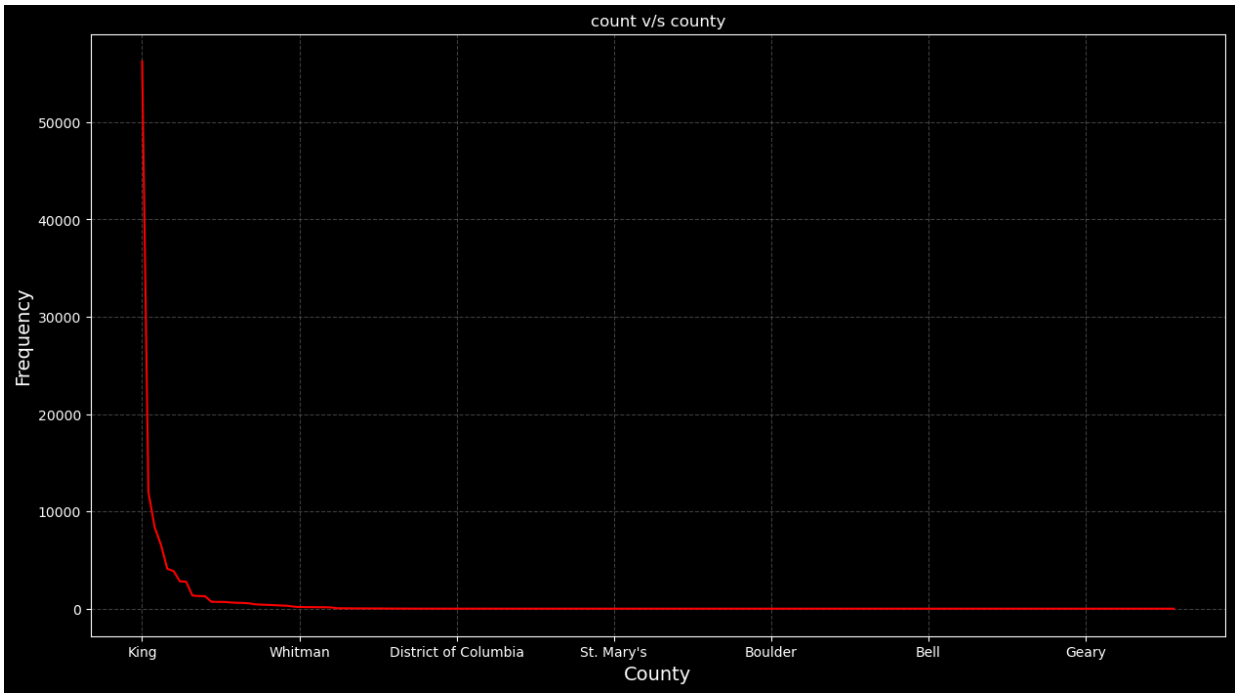
7.HIGHEST COUNTY IN DATASET

In [32]:
```
len(df.county.value_counts())
```

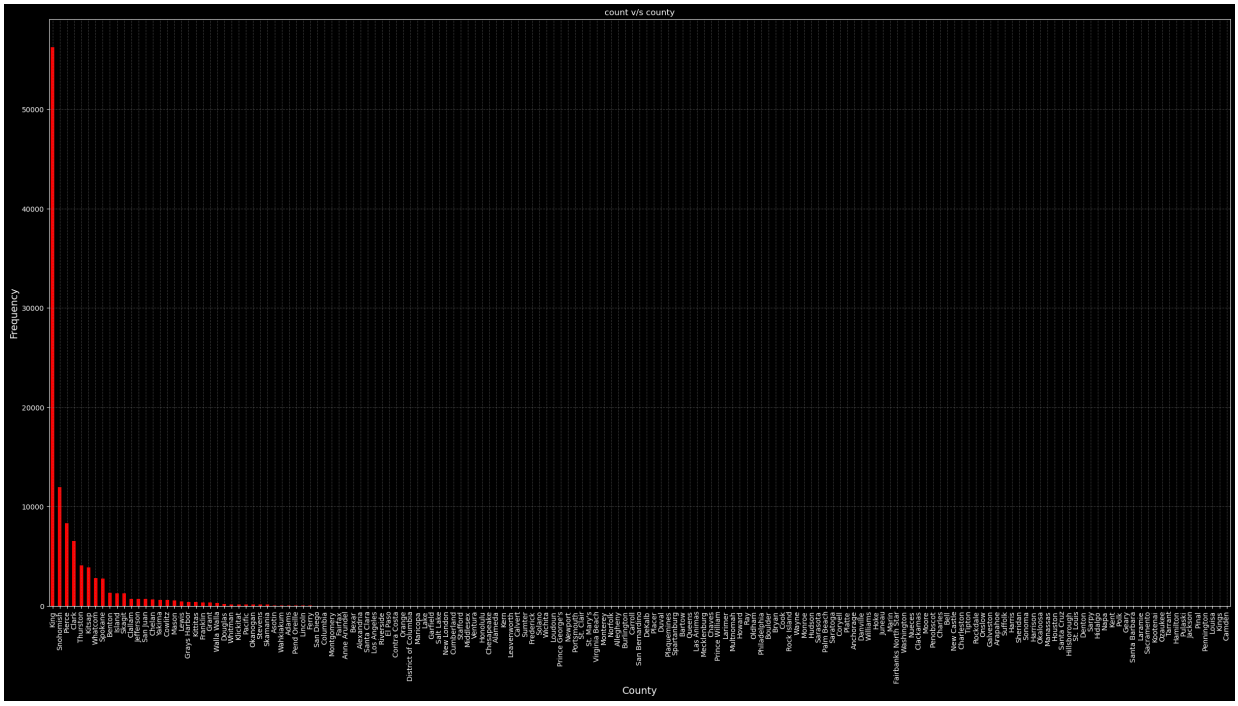
Out[32]:
```
165
```

We have total 165 counties on dataset.

In [33]:
```
plt.style.use('dark_background')
plt.figure(figsize=(15,8))
df.county.value_counts().plot(color="red")
plt.grid(linestyle='--', color='gray', alpha=0.5)
plt.xlabel("County",fontsize=14)
plt.ylabel("Frequency",fontsize=14)
plt.title("count v/s county")
plt.show()
```



In [34]:
```
plt.style.use('dark_background')
plt.figure(figsize=(30,15))
df.county.value_counts().plot.bar(color="red")
plt.grid(linestyle='--', color='gray', alpha=0.5)
plt.xlabel("County",fontsize=14)
plt.ylabel("Frequency",fontsize=14)
plt.title("count v/s county")
plt.show()
```



If we zoom our chart, we can see kings has the highest frequency in dataset. we can consider that king county has the highest amount of cars.

In [35]:
```
df.columns
```

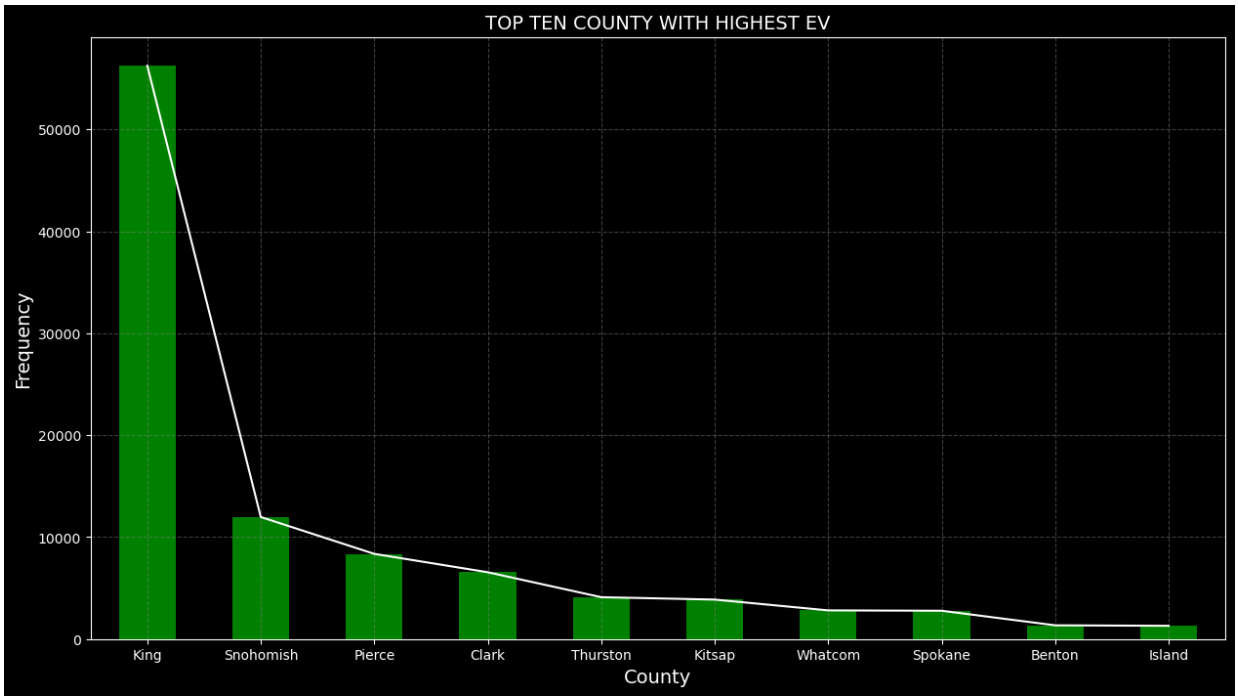
Out[35]:
```
Index(['county', 'city', 'state', 'postal_code', 'model_year', 'make', 'model',
       'electric_vehicle_type', 'clean_alternative_fuel_vehicle',
       'electric_range', 'base_msrp', 'legislative_district', 'dol_vehicle_id',
       '2020_census_tract'],
      dtype='object')
```

In [36]:
```
df.columns
```

Out[36]:
```
Index(['county', 'city', 'state', 'postal_code', 'model_year', 'make', 'model',
       'electric_vehicle_type', 'clean_alternative_fuel_vehicle',
       'electric_range', 'base_msrp', 'legislative_district', 'dol_vehicle_id',
       '2020_census_tract'],
      dtype='object')
```

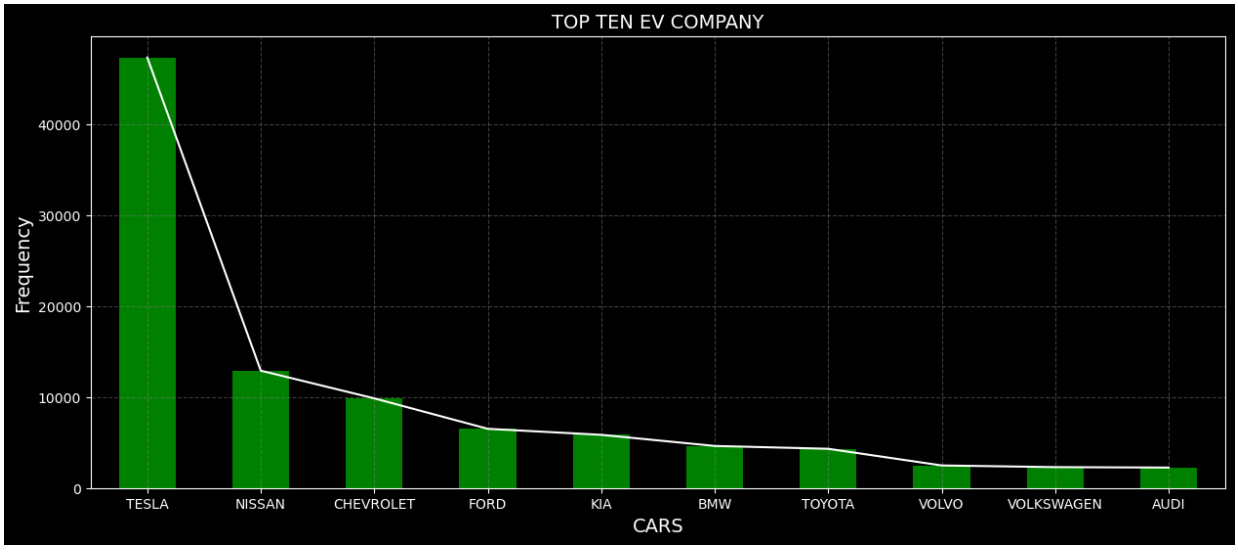
8. TOP TEN ELECTRIC CARS & COUNTY

In [37]:
```
top_5_county = df.county.value_counts().head(10)
plt.style.use('dark_background')
plt.figure(figsize=(15,8))
top_5_county.plot.bar(color="green")
top_5_county.plot(color="white")
plt.xlabel("County",fontsize=14)
plt.ylabel("Frequency",fontsize=14)
plt.title("TOP TEN COUNTY WITH HIGHEST EV",fontsize=14)
plt.grid(linestyle='--', color='gray', alpha=0.5)
plt.show()
```



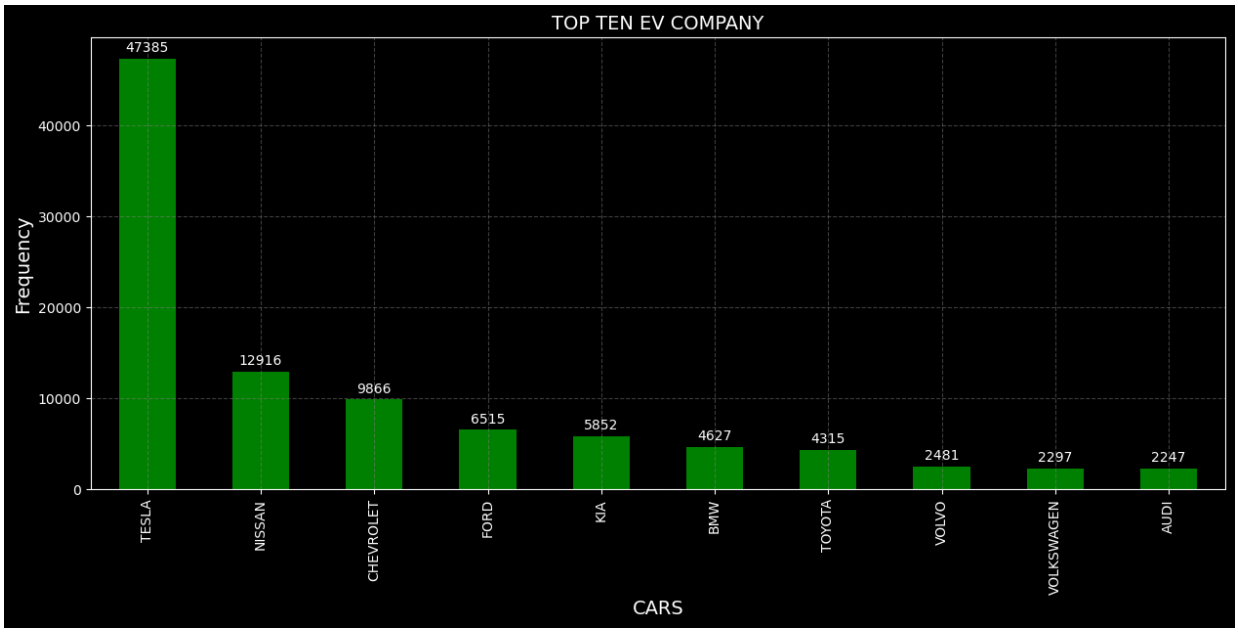
County name King and Snohomish has the highest electric car in United State.

In [38]:
```
top_5_make = df.make.value_counts().head(10)
plt.style.use('dark_background')
plt.figure(figsize=(15,6))
top_5_make.plot.bar(color="green")
top_5_make.plot(color="white")
plt.xlabel("CARS",fontsize=14)
plt.ylabel("Frequency",fontsize=14)
plt.title("TOP TEN EV COMPANY",fontsize=14)
plt.grid(linestyle='--', color='gray', alpha=0.5)
```



Tesla is the highest car selling company in the united state.

In [39]:
```
top_5_make = df.make.value_counts().head(10)
plt.style.use('dark_background')
plt.figure(figsize=(15,6))
ax = top_5_make.plot.bar(color="green")

for bar in ax.patches:
    height = bar.get_height()
    ax.annotate(f'{height}',
                xy=(bar.get_x() + bar.get_width() / 2, height),
                xytext=(0, 3),  # 3 points vertical offset
                textcoords="offset points",
                ha='center', va='bottom')

plt.xlabel("CARS",fontsize=14)
plt.ylabel("Frequency",fontsize=14)
plt.title("TOP TEN EV COMPANY",fontsize=14)
plt.grid(linestyle='--', color='gray', alpha=0.5)
plt.show()
```



TOP TEN SELLING CARS

1. Tesla is the first highest selling car
2. Nissan is the second highest selling car
3. Chevrolet is the third highest selling car
4. Ford is the fourth highest selling car
5. Kia is the fifth highest selling car
6. BMW is the sixth highest selling car
7. Toyota is the seventh highest selling car
8. Volvo is the eight highest selling car
9. Volkswagen is the ninth highest selling car
10. Audi is the tenth highest selling car

CREATING SEPRATE DATA FRAME ACCORDING TO CAR COMPANY

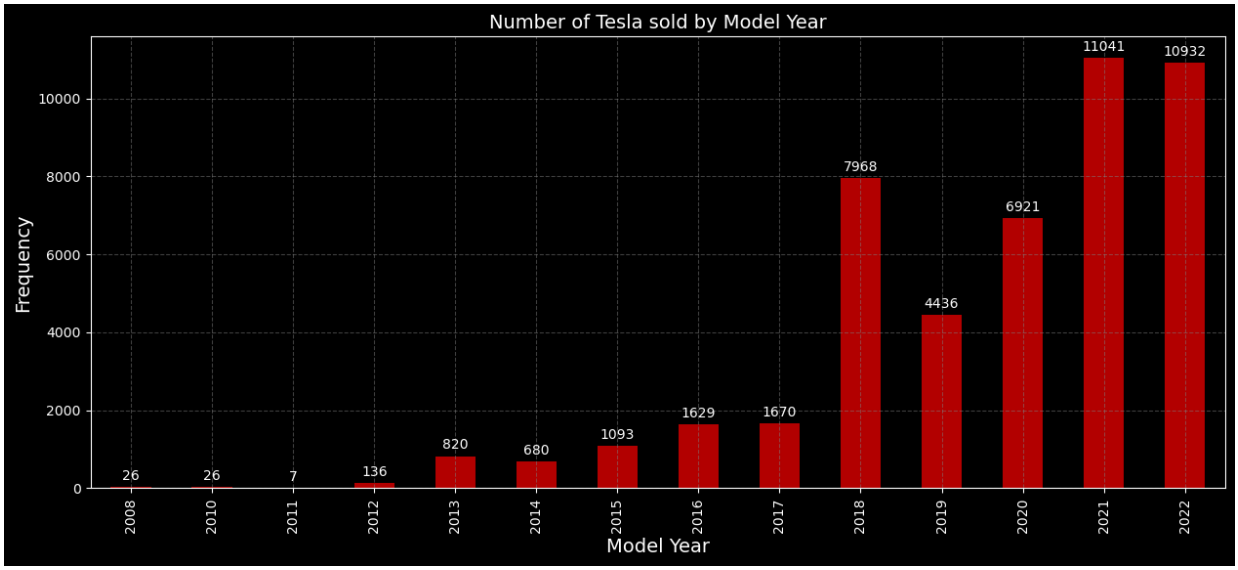
In [40]:
```
tesla = df[df["make"] == "TESLA"]
nissan = df[df["make"] == "NISSAN"]
kia = df[df["make"]=="KIA"]
ford = df[df["make"]=="FORD"]
chevrolet = df[df["make"]=="CHEVROLET"]
bmw = df[df["make"]=="BMW"]
toyota = df[df["make"]=="TOYOTA"]
audi =df[df["make"]=="AUDI"]
volkswagen = df[df["make"]=="VOLKSWAGEN"]
volvo = df[df["make"]=="VOLVO"]
```

9. TESLA CAR CHART

In [41]:
```
tesla.model_year.value_counts().sort_index()
```

Out[41]:
```
2008       26
2010       26
2011        7
2012      136
2013      820
2014      680
2015     1093
2016     1629
2017     1670
2018     7968
2019     4436
2020     6921
2021    11041
2022    10932
Name: model_year, dtype: int64
```

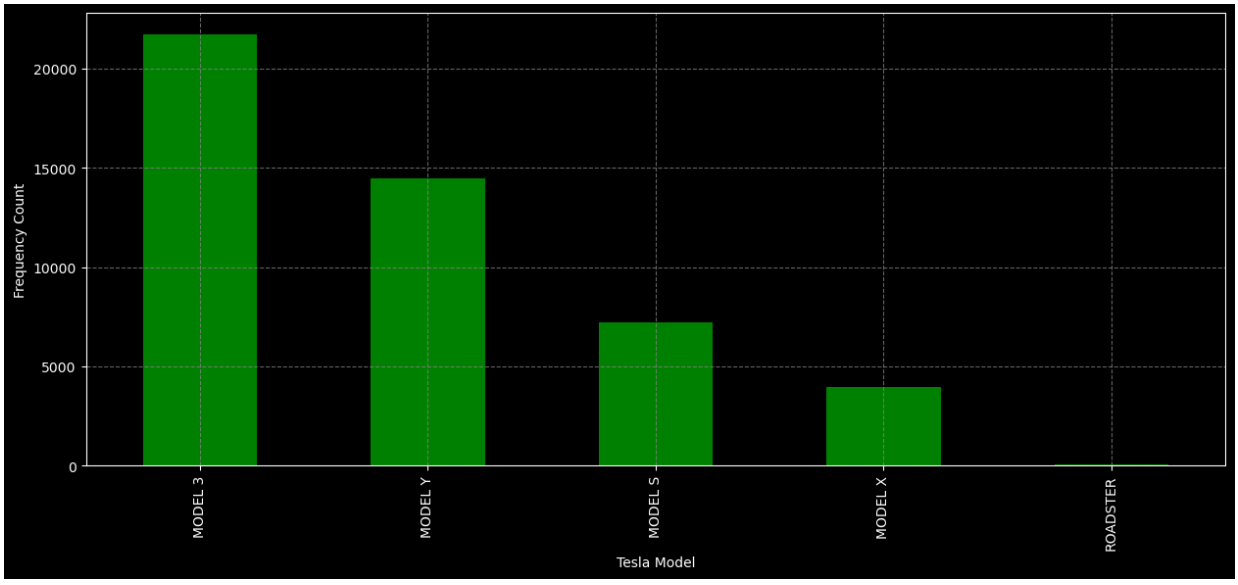
In [42]:
```
plt.style.use('dark_background')
plt.figure(figsize=(15,6))
ax = tesla.model_year.value_counts().sort_index().plot.bar(color="red", a

for bar in ax.patches:
    height = bar.get_height()
    ax.annotate(f'{height}',
                xy=(bar.get_x() + bar.get_width() / 2, height),
                xytext=(0, 3),  # 3 points vertical offset
                textcoords="offset points",
                ha='center', va='bottom')
plt.xlabel("Model Year",fontsize=14)
plt.ylabel("Frequency",fontsize=14)
plt.title("Number of Tesla sold by Model Year",fontsize=14)
plt.grid(linestyle='--', color='gray', alpha=0.5)
plt.show()
```



In [43]:
```
tesla.model.value_counts()
```

Out[43]:
```
MODEL 3     21715
MODEL Y     14468
MODEL S      7198
MODEL X      3945
ROADSTER       59
Name: model, dtype: int64
```

In [44]:
```
plt.style.use('dark_background')
plt.figure(figsize=(15,6))
tesla.model.value_counts().plot.bar(color="green")
plt.grid(linestyle='--', color='gray', alpha=0.8)
plt.xlabel("Tesla Model")
plt.ylabel("Frequency Count")
plt.show()
```



In [45]:
```
tesla_stock['Date'] = [d.to_pydatetime().toordinal() for d in tesla_stock
```

In [46]:
```
y = tesla_stock.Close.values.reshape(-1,1)
x = tesla_stock['Date'].values.reshape(-1,1)
```

In [47]:
```
Model = LineModel(x,y)
Model.LinearRegression()
```

Out[47]: (-0.39659685011007517, 293087.4266242092)

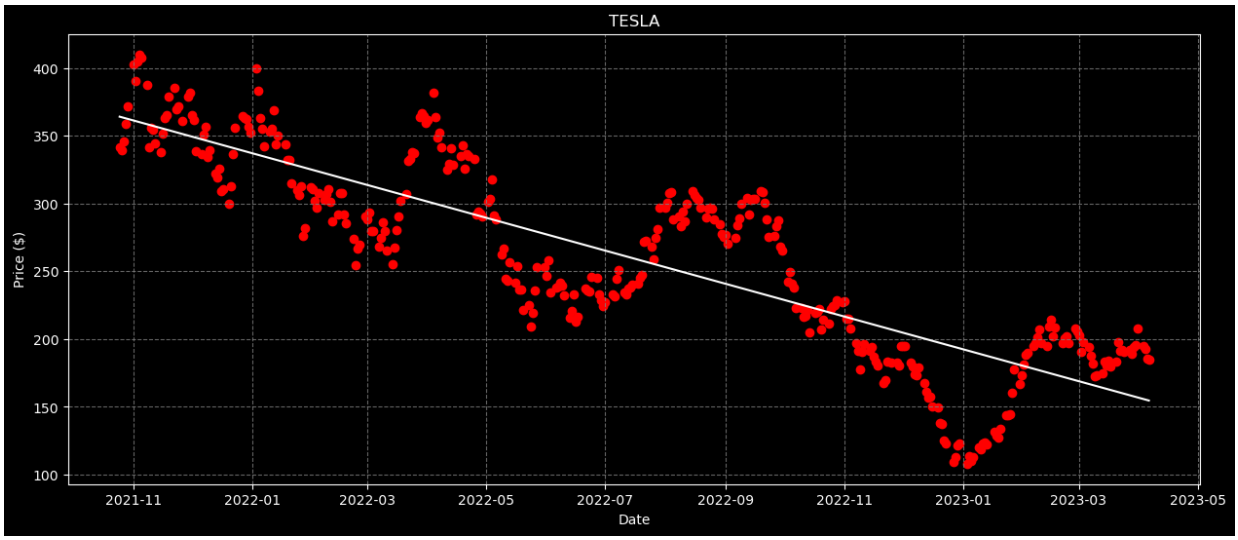
In [48]:
```
y_pred = Model.predict(x)
```

In [49]:
```
print(f"The predicted values of y are: \n\n{y_pred[:20]}")
```

```
The predicted values of y are:

[[364.05072016]
 [363.65412331]
 [363.25752646]
 [362.86092961]
 [362.46433276]
 [361.27454221]
 [360.87794536]
 [360.48134851]
 [360.08475166]
 [359.68815481]
 [358.49836426]
 [358.10176741]
 [357.70517056]
 [357.30857371]
 [356.91197686]
 [355.72218631]
 [355.32558946]
 [354.92899261]
 [354.53239576]
 [354.13579891]]
```

In [50]:
```
x = [datetime.date.fromordinal(int(d)) for d in x.flatten()]
```

In [51]:
```
plt.style.use('dark_background')
plt.figure(figsize=(15,6))
plt.scatter(x,y, color="red")
plt.plot(x,y_pred, color="white")
plt.grid(linestyle='--', color='gray', alpha=0.8)
plt.title("TESLA")
plt.ylabel("Price ($)")
plt.xlabel("Date")
plt.show()
plt.close()
```



In [52]:
```
X = snp500.Close
y = tesla_stock.Close.values
```

In [53]:
```
splitter = TrainTestSplit(X, y, test_size=0.2)
splitter
```

Out[53]:
```
<__main__.TrainTestSplit at 0x7fb7e683c130>
```

In [54]:
```
X_train, X_test, y_train, y_test = splitter.split()
```

In [55]:
```
print(X_train.shape)
print(y_train.shape)
```

```
(292,)
(292,)
```

In [56]:
```
print(X_test.shape)
print(y_test.shape)
```

```
(73,)
(73,)
```

In [57]:
```
Model = LineModel(X_train,y_train)
Model.LinearRegression()
```

Out[57]:
```
(0.17213816350867395, -454.3551901629965)
```

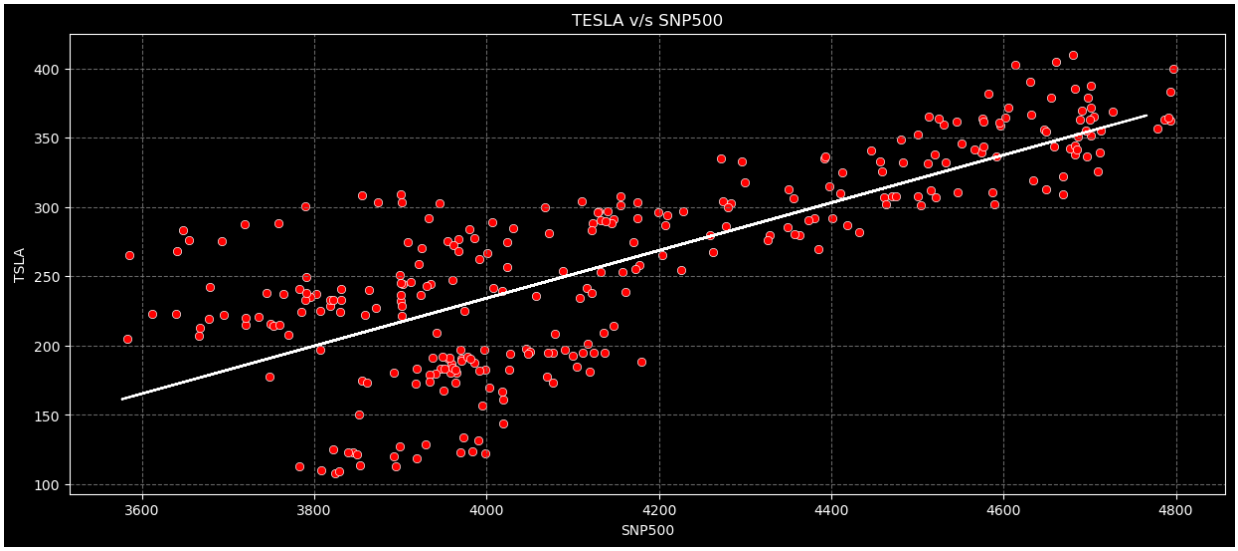
In [58]:
```
y_pred = Model.predict(X_test)
```

In [59]:
```
y_pred[:5]
```

Out[59]:
```
Date
2023-02-09 00:00:00-05:00    248.226724
2023-04-05 00:00:00-04:00    249.755291
2022-11-08 00:00:00-05:00    204.608653
2022-08-16 00:00:00-04:00    286.734065
2022-02-24 00:00:00-05:00    283.893785
Name: Close, dtype: float64
```

In [60]:
```
data = {'X_train': X_train, 'y_train': y_train}
data = pd.DataFrame(data)
```

In [61]:
```
plt.style.use('dark_background')
plt.figure(figsize=(15,6))
sns.scatterplot(x='X_train', y='y_train', data=data, color="red")
plt.plot(X_test, y_pred, color="white")
plt.grid(linestyle='--', color='gray', alpha=0.8)
plt.title("TESLA v/s SNP500")
plt.ylabel("TSLA")
plt.xlabel("SNP500")
plt.show()
plt.close()
```

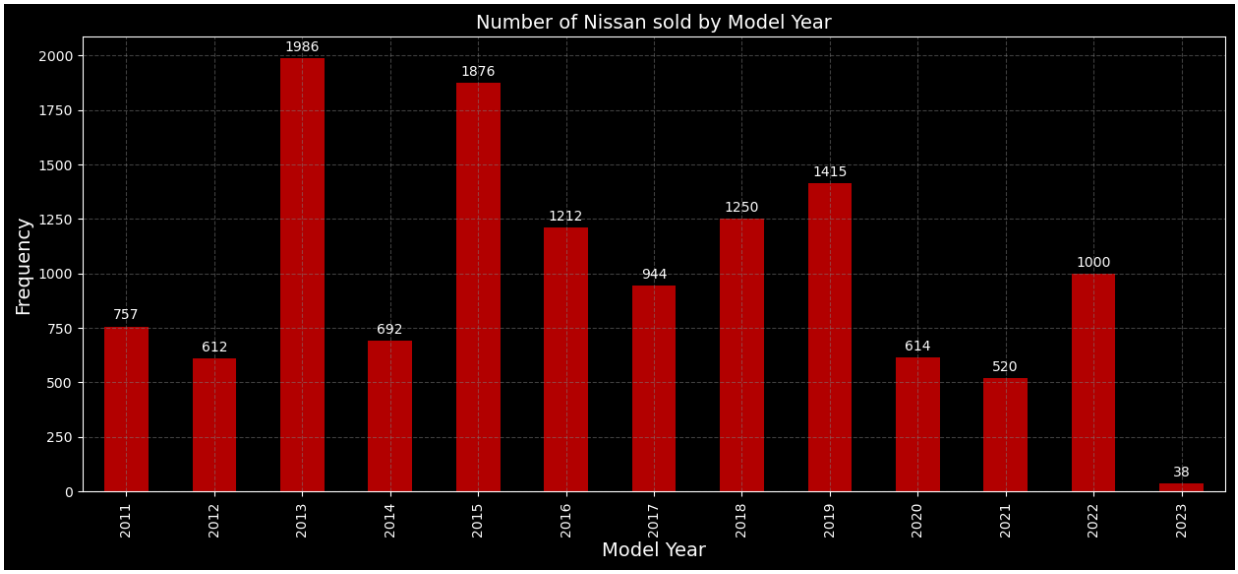


10. NISSAN CAR CHART

In [62]:
```
nissan.model_year.value_counts().sort_index()
```

Out[62]:
```
2011     757
2012     612
2013    1986
2014     692
2015    1876
2016    1212
2017     944
2018    1250
2019    1415
2020     614
2021     520
2022    1000
2023      38
Name: model_year, dtype: int64
```

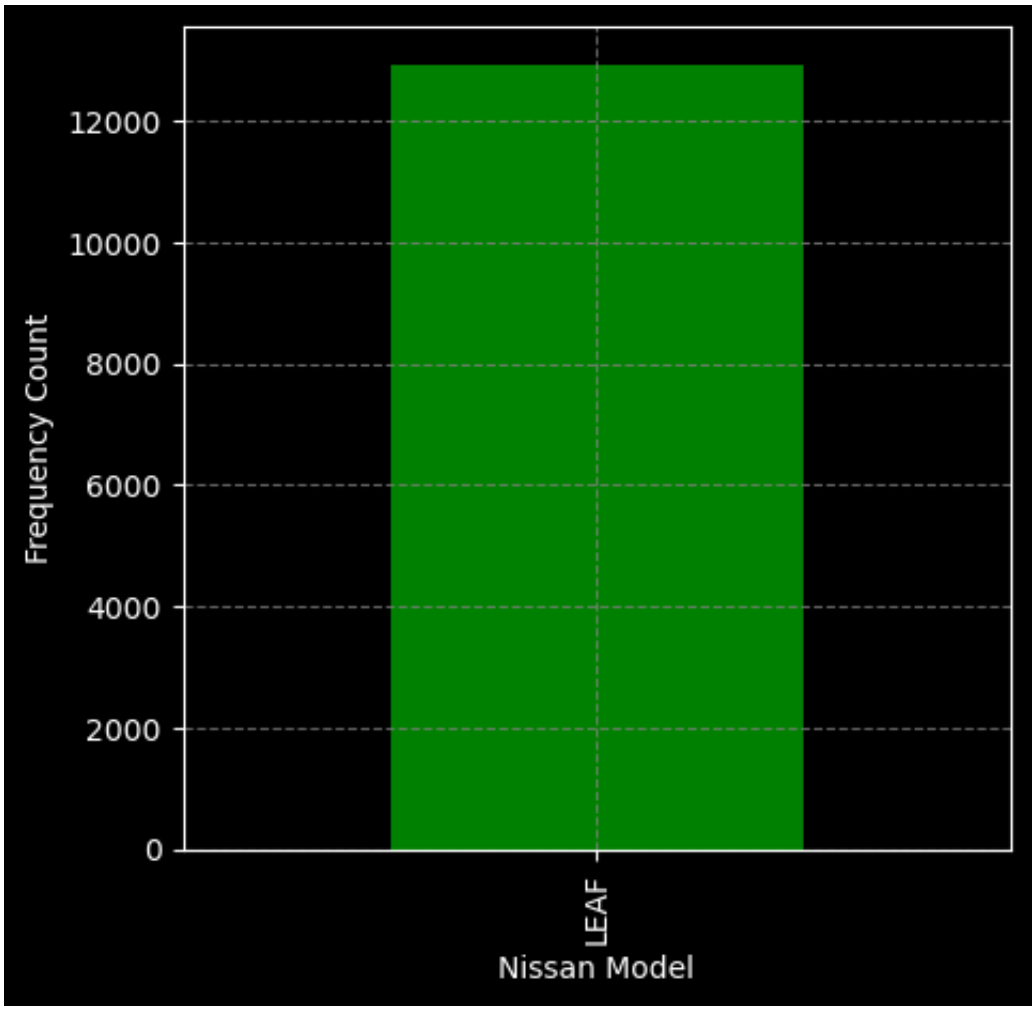
In [63]:
```
plt.style.use('dark_background')
plt.figure(figsize=(15,6))
ax = nissan.model_year.value_counts().sort_index().plot.bar(color="red",

for bar in ax.patches:
    height = bar.get_height()
    ax.annotate(f'{height}',
                xy=(bar.get_x() + bar.get_width() / 2, height),
                xytext=(0, 3),  # 3 points vertical offset
                textcoords="offset points",
                ha='center', va='bottom')
plt.xlabel("Model Year",fontsize=14)
plt.ylabel("Frequency",fontsize=14)
plt.title("Number of Nissan sold by Model Year",fontsize=14)
plt.grid(linestyle='--', color='gray', alpha=0.5)
plt.show()
```



In [64]:
```
nissan.model.value_counts()
```

Out[64]:
```
LEAF    12916
Name: model, dtype: int64
```

In [154…
```
plt.style.use('dark_background')
plt.figure(figsize=(5,5))
nissan.model.value_counts().plot.bar(color="green")
plt.grid(linestyle='--', color='gray', alpha=0.8)
plt.xlabel("Nissan Model")
plt.ylabel("Frequency Count")
plt.show()
```

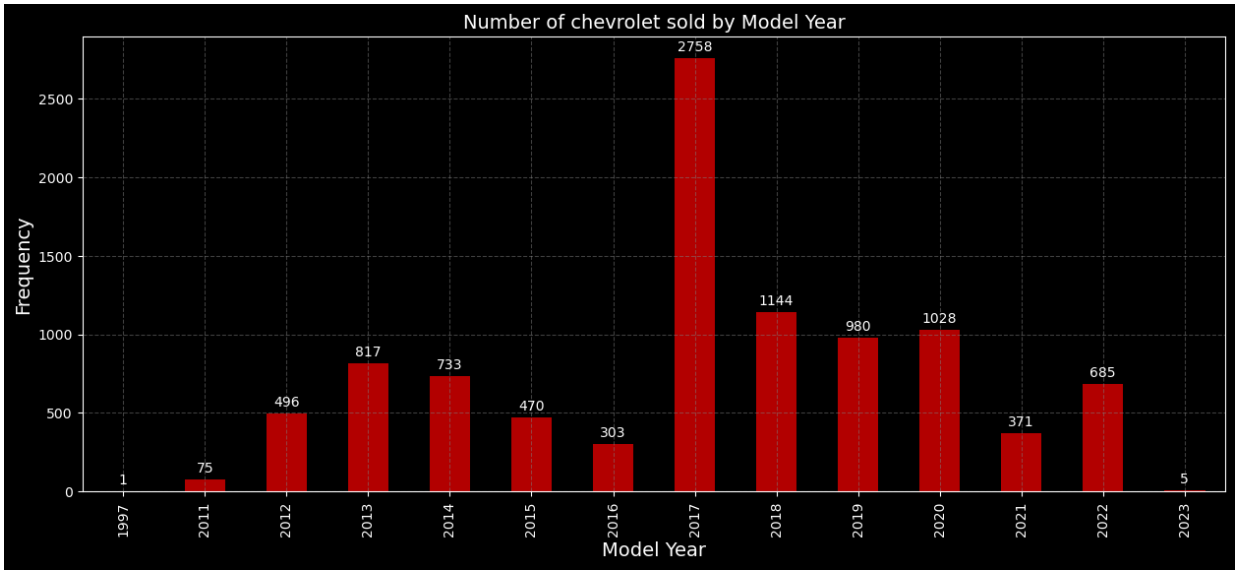


11. CHEVROLET CAR CHART

In [78]:
```
chevrolet.model_year.value_counts()
```

Out[78]:
```
2017    2758
2018    1144
2020    1028
2019     980
2013     817
2014     733
2022     685
2012     496
2015     470
2021     371
2016     303
2011      75
2023       5
1997       1
Name: model_year, dtype: int64
```

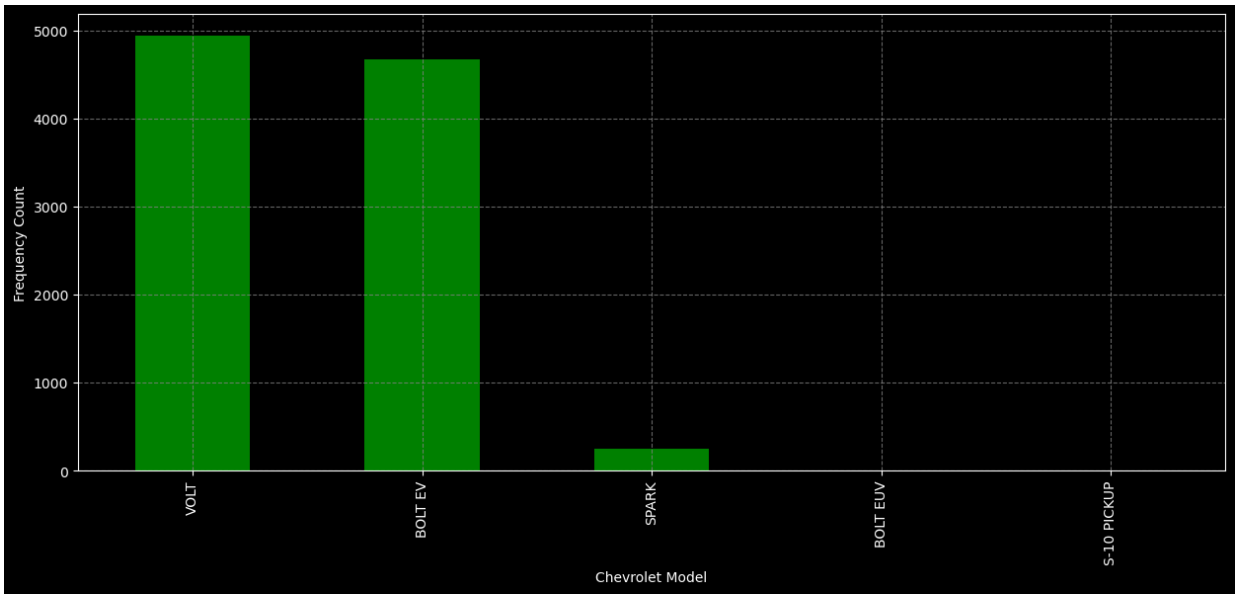
In [79]:
```
plt.style.use('dark_background')
plt.figure(figsize=(15,6))
ax = chevrolet.model_year.value_counts().sort_index().plot.bar(color="red

for bar in ax.patches:
    height = bar.get_height()
    ax.annotate(f'{height}',
                xy=(bar.get_x() + bar.get_width() / 2, height),
                xytext=(0, 3),  # 3 points vertical offset
                textcoords="offset points",
                ha='center', va='bottom')
plt.xlabel("Model Year",fontsize=14)
plt.ylabel("Frequency",fontsize=14)
plt.title("Number of chevrolet sold by Model Year",fontsize=14)
plt.grid(linestyle='--', color='gray', alpha=0.5)
plt.show()
```



In [80]:
```
chevrolet.model.value_counts()
```

Out[80]:
```
VOLT           4938
BOLT EV        4675
SPARK           249
BOLT EUV          3
S-10 PICKUP       1
Name: model, dtype: int64
```

In [81]:
```
plt.style.use('dark_background')
plt.figure(figsize=(15,6))
chevrolet.model.value_counts().plot.bar(color="green")
plt.grid(linestyle='--', color='gray', alpha=0.8)
plt.xlabel("Chevrolet Model")
plt.ylabel("Frequency Count")
plt.show()
```



In [190…
```
general_motor_stock = Stock("GM").Price("GM").tail(days)
```

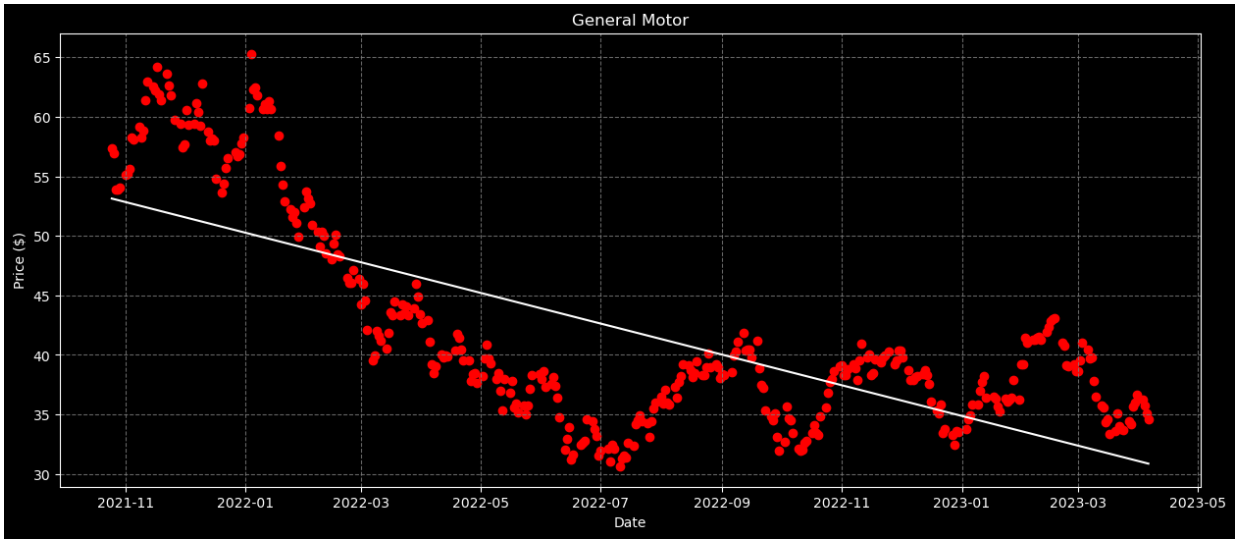
In [191…
```
general_motor_stock['Date'] = [d.to_pydatetime().toordinal() for d in gen
```

In [192…
```
y = general_motor_stock.Close.values.reshape(-1,1)
x = general_motor_stock['Date'].values.reshape(-1,1)
```

In [193…
```
Model = LineModel(x,y)
Model.LinearRegression()
y_pred = Model.predict(x)
```

In [194…
```
x = [datetime.date.fromordinal(int(d)) for d in x.flatten()]
```

In [196…
```
plt.style.use('dark_background')
plt.figure(figsize=(15,6))
plt.scatter(x,y, color="red")
plt.plot(x,y_pred, color="white")
plt.grid(linestyle='--', color='gray', alpha=0.8)
plt.title("General Motor")
plt.ylabel("Price ($)")
plt.xlabel("Date")
plt.show()
plt.close()
```



In [197…
```
X = snp500.Close
y = general_motor_stock.Close.values
```

In [198…
```
splitter = TrainTestSplit(X, y, test_size=0.2)
X_train, X_test, y_train, y_test = splitter.split()
```

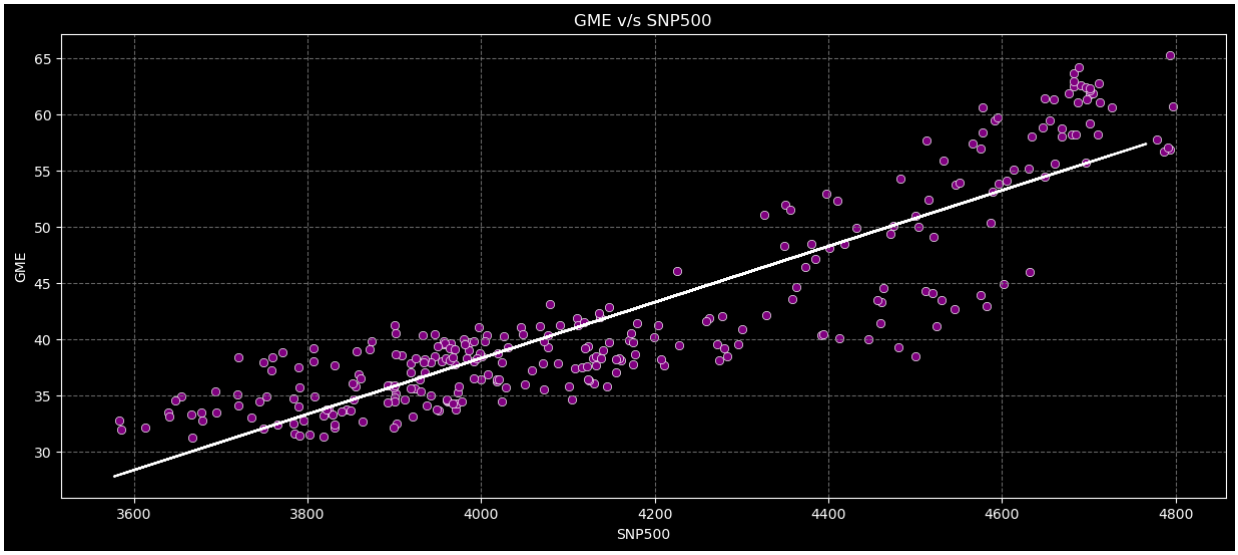
In [199…
```
Model = LineModel(X_train,y_train)
Model.LinearRegression()
```

Out[199]: (0.02490776191037854, -61.34506425054585)

In [200…
```
y_pred = Model.predict(X_test)
```

In [201…
```
data = {'X_train': X_train, 'y_train': y_train}
data = pd.DataFrame(data)
```

In [203…
```
plt.style.use('dark_background')
plt.figure(figsize=(15,6))
sns.scatterplot(x='X_train', y='y_train', data=data, color="purple")
plt.plot(X_test, y_pred, color="white")
plt.grid(linestyle='--', color='gray', alpha=0.8)
plt.title("GME v/s SNP500")
plt.ylabel("GME")
plt.xlabel("SNP500")
plt.show()
plt.close()
```

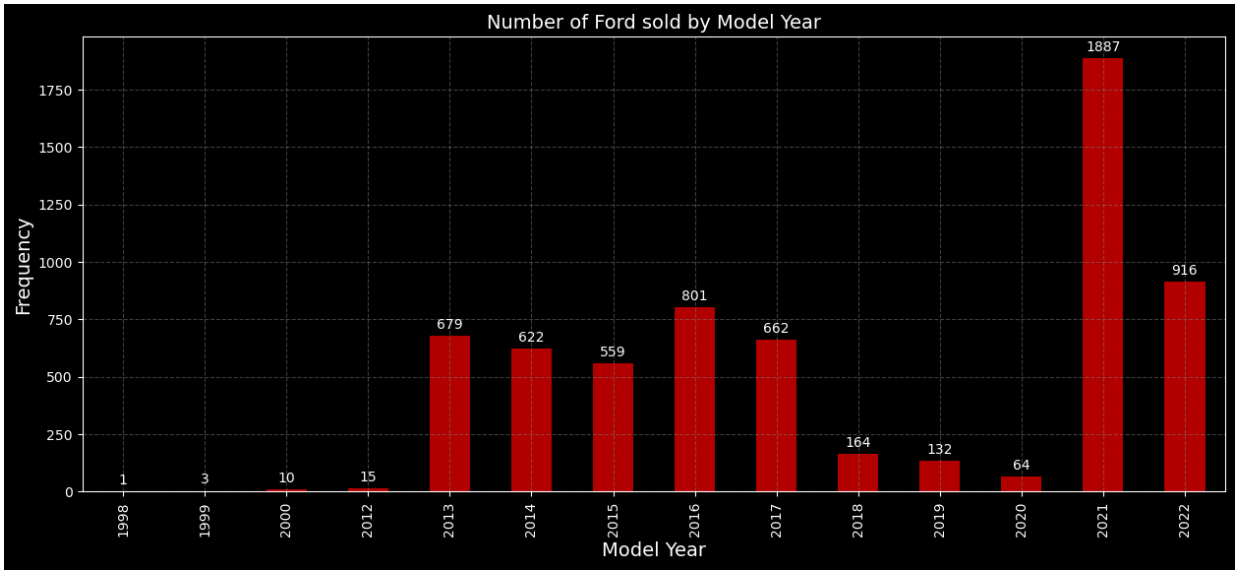


12. FORD CAR CHART

In [82]:
```
ford.model_year.value_counts()
```

Out[82]:
```
2021    1887
2022     916
2016     801
2013     679
2017     662
2014     622
2015     559
2018     164
2019     132
2020      64
2012      15
2000      10
1999       3
1998       1
Name: model_year, dtype: int64
```

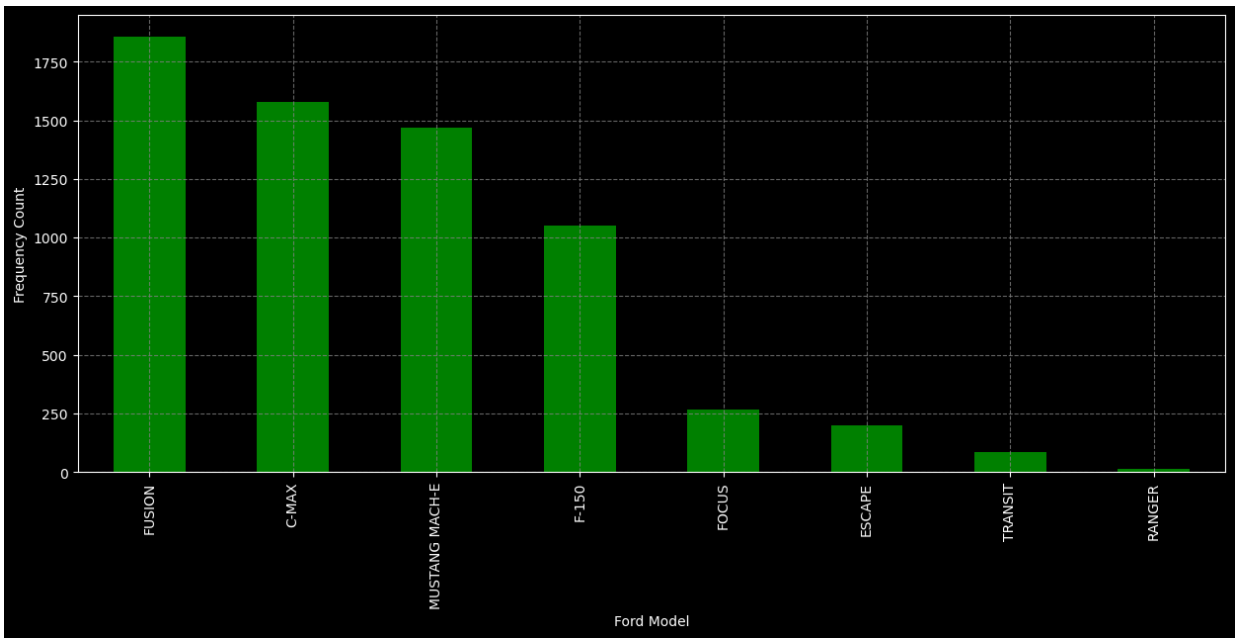
In [83]:
```
plt.style.use('dark_background')
plt.figure(figsize=(15,6))
ax = ford.model_year.value_counts().sort_index().plot.bar(color="red", al

for bar in ax.patches:
    height = bar.get_height()
    ax.annotate(f'{height}',
                xy=(bar.get_x() + bar.get_width() / 2, height),
                xytext=(0, 3),  # 3 points vertical offset
                textcoords="offset points",
                ha='center', va='bottom')
plt.xlabel("Model Year",fontsize=14)
plt.ylabel("Frequency",fontsize=14)
plt.title("Number of Ford sold by Model Year",fontsize=14)
plt.grid(linestyle='--', color='gray', alpha=0.5)
plt.show()
```



In [84]:
```
ford.model.value_counts()
```

Out[84]:
```
FUSION            1856
C-MAX             1577
MUSTANG MACH-E    1467
F-150             1053
FOCUS              265
ESCAPE             198
TRANSIT             85
RANGER              14
Name: model, dtype: int64
```

In [85]:
```
plt.style.use('dark_background')
plt.figure(figsize=(15,6))
ford.model.value_counts().plot.bar(color="green")
plt.grid(linestyle='--', color='gray', alpha=0.8)
plt.xlabel("Ford Model")
plt.ylabel("Frequency Count")
plt.show()
```



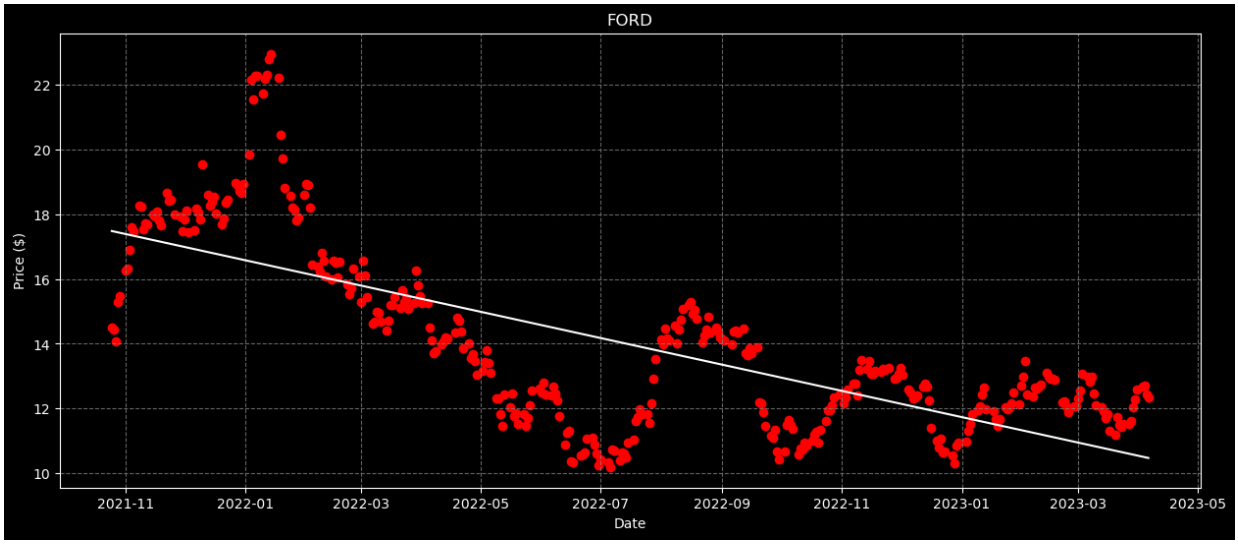
In [86]:
```
ford_stock['Date'] = [d.to_pydatetime().toordinal() for d in ford_stock.i
```

In [87]:
```
y = ford_stock.Close.values.reshape(-1,1)
x = ford_stock['Date'].values.reshape(-1,1)
```

In [88]:
```
Model = LineModel(x,y)
Model.LinearRegression()
y_pred = Model.predict(x)
```

In [89]:
```
x = [datetime.date.fromordinal(int(d)) for d in x.flatten()]
```

In [90]:
```
plt.style.use('dark_background')
plt.figure(figsize=(15,6))
plt.scatter(x,y, color="red")
plt.plot(x,y_pred, color="white")
plt.grid(linestyle='--', color='gray', alpha=0.8)
plt.title("FORD")
plt.ylabel("Price ($)")
plt.xlabel("Date")
plt.show()
plt.close()
```



In [91]:
```
X = snp500.Close
y = ford_stock.Close.values
```

In [92]:
```
splitter = TrainTestSplit(X, y, test_size=0.2)
X_train, X_test, y_train, y_test = splitter.split()
```

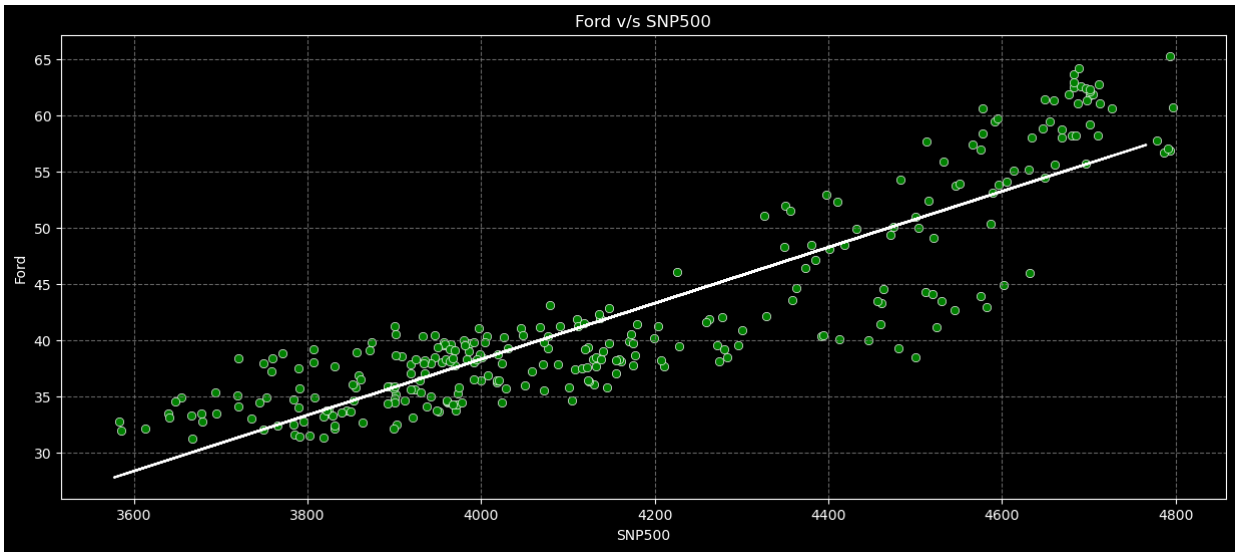
In [93]:
```
Model = LineModel(X_train,y_train)
Model.LinearRegression()
```

Out[93]:
```
(0.007821838172818256, -18.49569547520846)
```

In [94]:
```
y_pred = Model.predict(X_test)
data = {'X_train': X_train, 'y_train': y_train}
data = pd.DataFrame(data)
```

In [204…

```
plt.style.use('dark_background')
plt.figure(figsize=(15,6))
sns.scatterplot(x='X_train', y='y_train', data=data, color="green")
plt.plot(X_test, y_pred, color="white")
plt.grid(linestyle='--', color='gray', alpha=0.8)
plt.title("Ford v/s SNP500")
plt.ylabel("Ford")
plt.xlabel("SNP500")
plt.show()
plt.close()
```



13. KIA CAR CHART

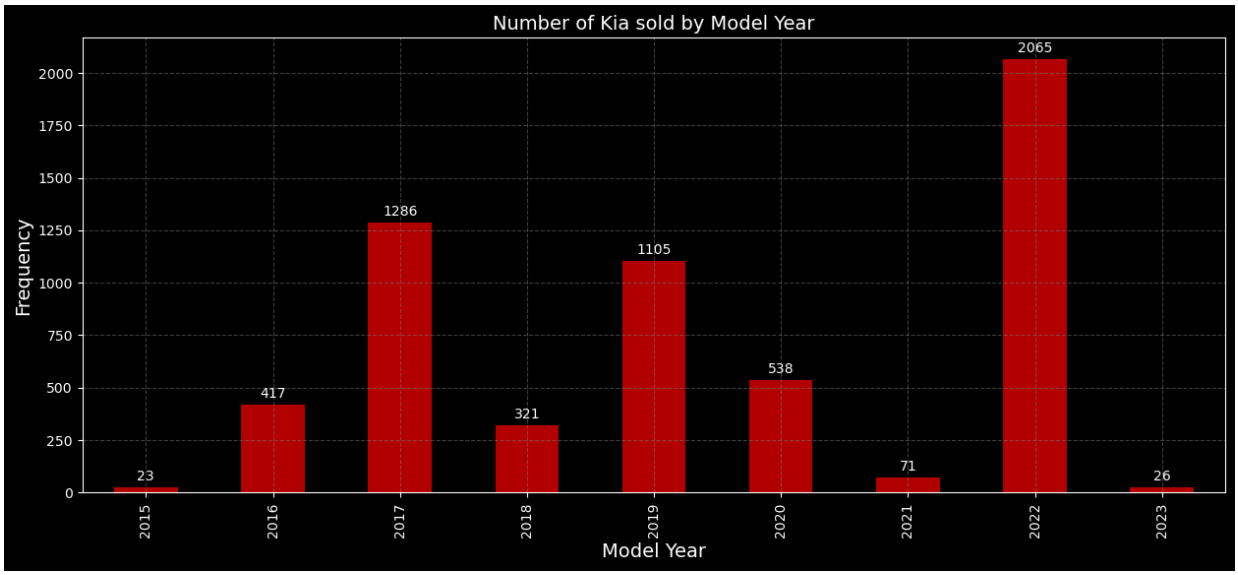
In [96]:

```
kia.model_year.value_counts().sort_index()
```

Out[96]:

```
2015      23
2016     417
2017    1286
2018     321
2019    1105
2020     538
2021      71
2022    2065
2023      26
Name: model_year, dtype: int64
```

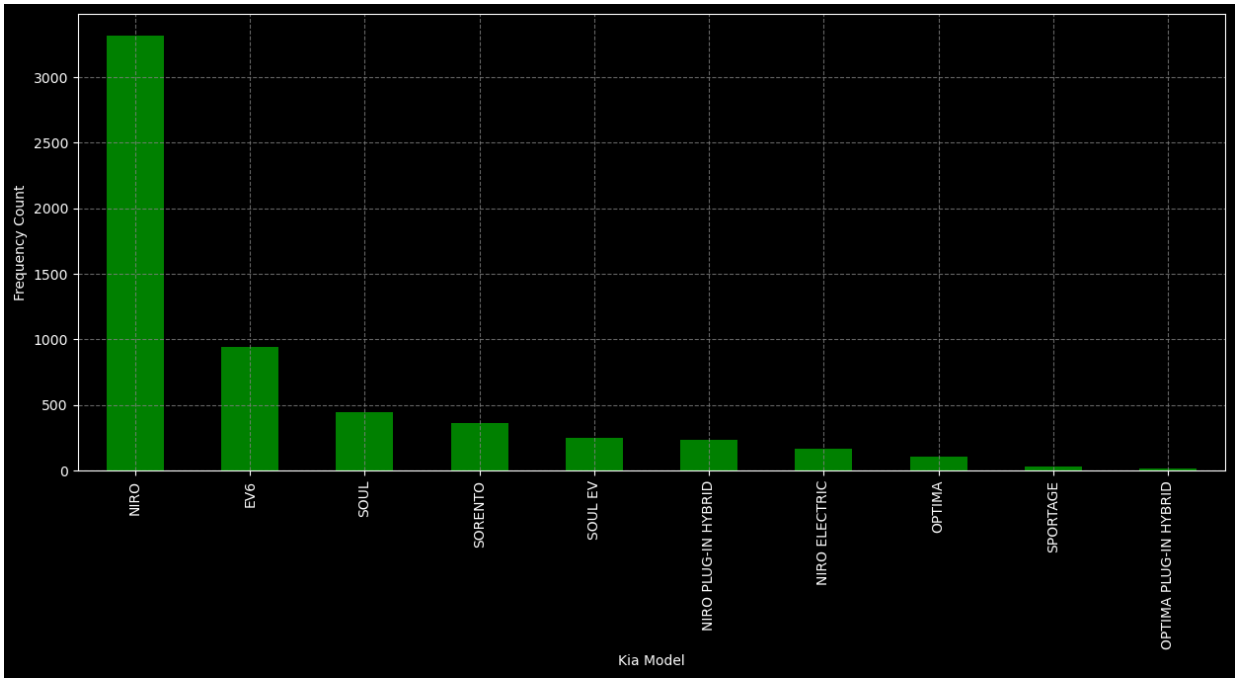
In [97]:
```
plt.style.use('dark_background')
plt.figure(figsize=(15,6))
ax = kia.model_year.value_counts().sort_index().plot.bar(color="red", alp

for bar in ax.patches:
    height = bar.get_height()
    ax.annotate(f'{height}',
                xy=(bar.get_x() + bar.get_width() / 2, height),
                xytext=(0, 3),  # 3 points vertical offset
                textcoords="offset points",
                ha='center', va='bottom')
plt.xlabel("Model Year",fontsize=14)
plt.ylabel("Frequency",fontsize=14)
plt.title("Number of Kia sold by Model Year",fontsize=14)
plt.grid(linestyle='--', color='gray', alpha=0.5)
plt.show()
```



In [98]:
```
kia.model.value_counts()
```

Out[98]:
```
NIRO                    3318
EV6                      939
SOUL                     440
SORENTO                  363
SOUL EV                  244
NIRO PLUG-IN HYBRID      234
NIRO ELECTRIC            166
OPTIMA                   106
SPORTAGE                  26
OPTIMA PLUG-IN HYBRID     16
Name: model, dtype: int64
```

In [99]:
```
plt.style.use('dark_background')
plt.figure(figsize=(15,6))
kia.model.value_counts().plot.bar(color="green")
plt.grid(linestyle='--', color='gray', alpha=0.8)
plt.xlabel("Kia Model")
plt.ylabel("Frequency Count")
plt.show()
```

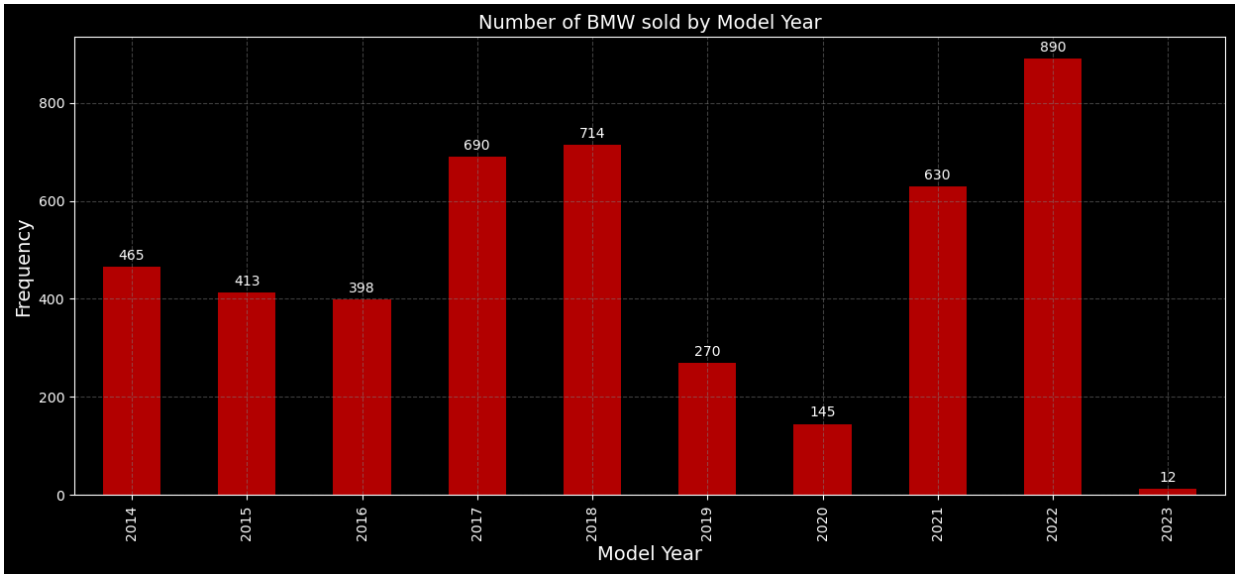


14. BMW CAR CHART

In [100…
```
bmw.model_year.value_counts().sort_index()
```

Out[100]:
```
2014    465
2015    413
2016    398
2017    690
2018    714
2019    270
2020    145
2021    630
2022    890
2023     12
Name: model_year, dtype: int64
```

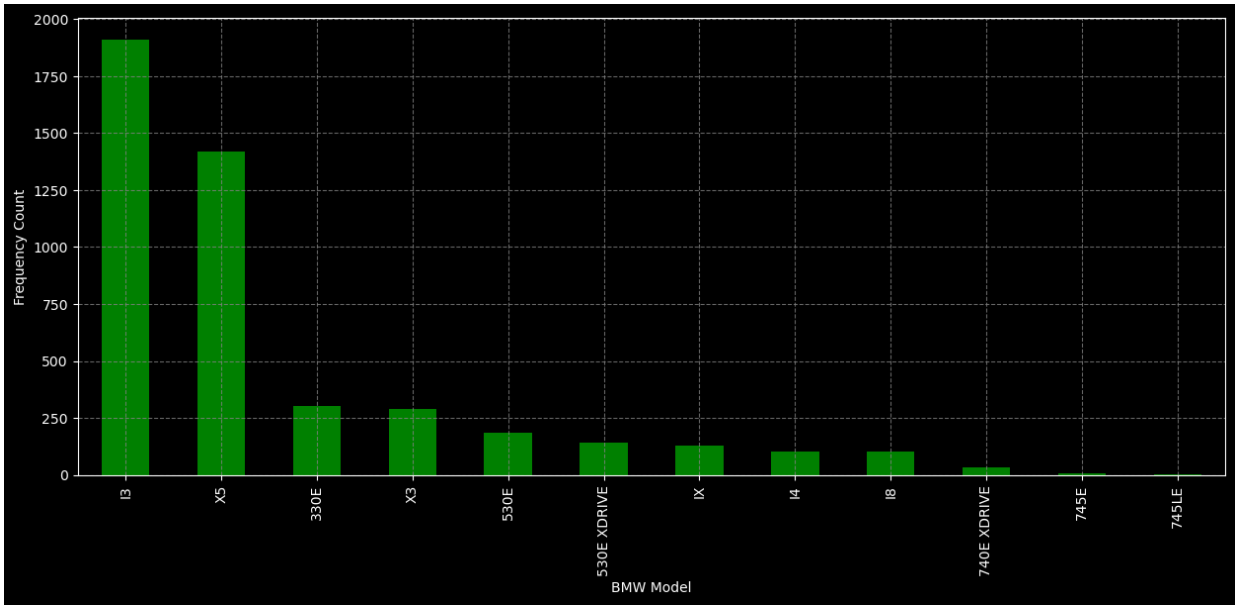
In [101…
```
plt.style.use('dark_background')
plt.figure(figsize=(15,6))
ax = bmw.model_year.value_counts().sort_index().plot.bar(color="red", alp

for bar in ax.patches:
    height = bar.get_height()
    ax.annotate(f'{height}',
                xy=(bar.get_x() + bar.get_width() / 2, height),
                xytext=(0, 3),  # 3 points vertical offset
                textcoords="offset points",
                ha='center', va='bottom')
plt.xlabel("Model Year",fontsize=14)
plt.ylabel("Frequency",fontsize=14)
plt.title("Number of BMW sold by Model Year",fontsize=14)
plt.grid(linestyle='--', color='gray', alpha=0.5)
plt.show()
```



In [102…
```
bmw.model.value_counts()
```

Out[102]:
```
I3              1911
X5              1421
330E             303
X3               289
530E             185
530E XDRIVE      140
IX               130
I4               104
I8               103
740E XDRIVE       32
745E               7
745LE              2
Name: model, dtype: int64
```

In [155…
```
plt.style.use('dark_background')
plt.figure(figsize=(15,6))
bmw.model.value_counts().plot.bar(color="green")
plt.grid(linestyle='--', color='gray', alpha=0.8)
plt.xlabel("BMW Model")
plt.ylabel("Frequency Count")
plt.show()
```

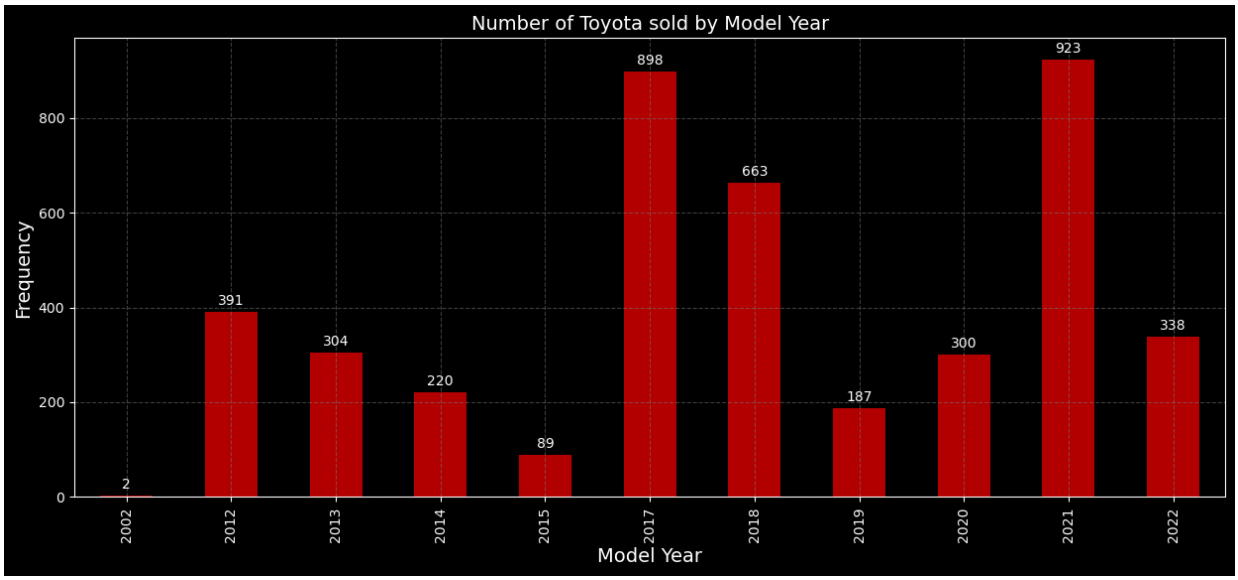


15. TOYOTA CAR CHART

In [104…
```
toyota.model_year.value_counts().sort_index()
```

Out[104]:
```
2002      2
2012    391
2013    304
2014    220
2015     89
2017    898
2018    663
2019    187
2020    300
2021    923
2022    338
Name: model_year, dtype: int64
```

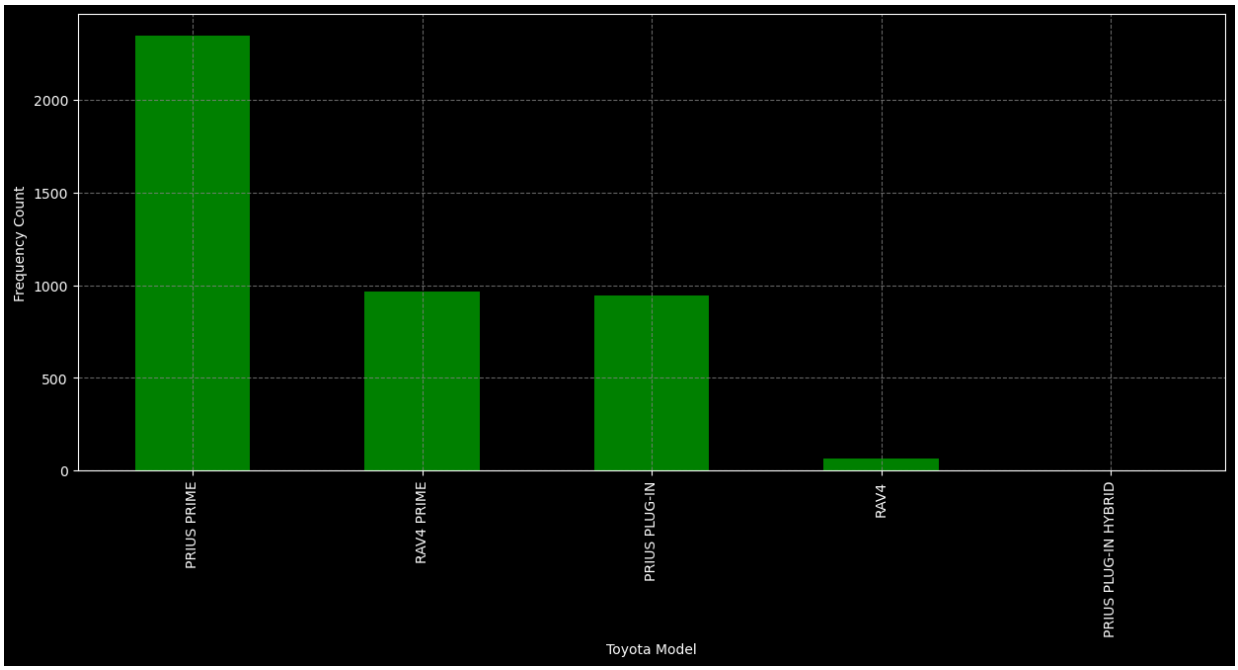
In [105…
```
plt.style.use('dark_background')
plt.figure(figsize=(15,6))
ax = toyota.model_year.value_counts().sort_index().plot.bar(color="red",

for bar in ax.patches:
    height = bar.get_height()
    ax.annotate(f'{height}',
                xy=(bar.get_x() + bar.get_width() / 2, height),
                xytext=(0, 3),  # 3 points vertical offset
                textcoords="offset points",
                ha='center', va='bottom')
plt.xlabel("Model Year",fontsize=14)
plt.ylabel("Frequency",fontsize=14)
plt.title("Number of Toyota sold by Model Year",fontsize=14)
plt.grid(linestyle='--', color='gray', alpha=0.5)
plt.show()
```



In [106…
```
toyota.model.value_counts()
```

Out[106]:
```
PRIUS PRIME              2346
RAV4 PRIME                963
PRIUS PLUG-IN             942
RAV4                       63
PRIUS PLUG-IN HYBRID        1
Name: model, dtype: int64
```

In [156…
```
plt.style.use('dark_background')
plt.figure(figsize=(15,6))
toyota.model.value_counts().plot.bar(color="green")
plt.grid(linestyle='--', color='gray', alpha=0.8)
plt.xlabel("Toyota Model")
plt.ylabel("Frequency Count")
plt.show()
```

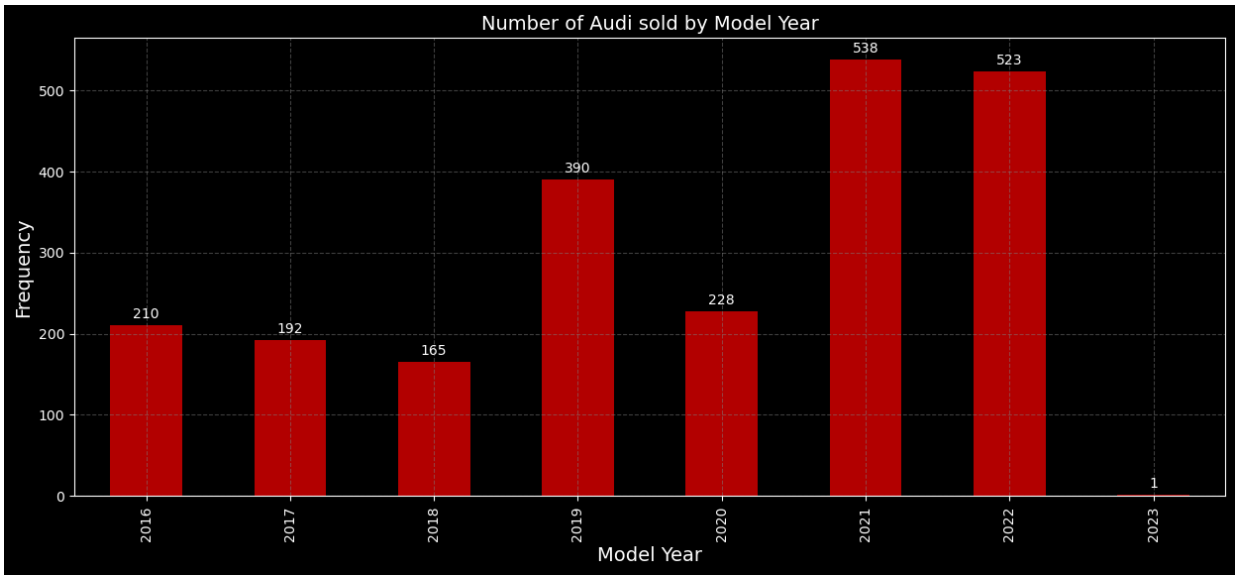


16. AUDI CAR CHART

In [108…
```
audi.model_year.value_counts().sort_index()
```

Out[108]:
```
2016    210
2017    192
2018    165
2019    390
2020    228
2021    538
2022    523
2023      1
Name: model_year, dtype: int64
```

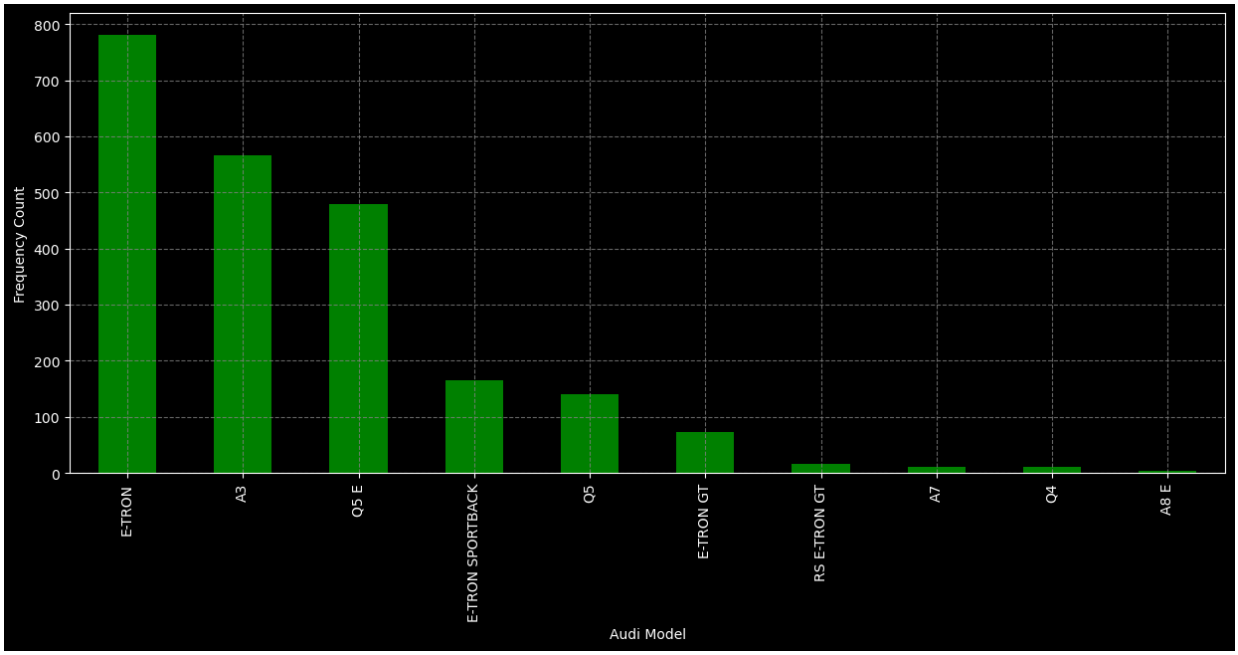
In [109…
```
plt.style.use('dark_background')
plt.figure(figsize=(15,6))
ax = audi.model_year.value_counts().sort_index().plot.bar(color="red", al

for bar in ax.patches:
    height = bar.get_height()
    ax.annotate(f'{height}',
                xy=(bar.get_x() + bar.get_width() / 2, height),
                xytext=(0, 3),  # 3 points vertical offset
                textcoords="offset points",
                ha='center', va='bottom')
plt.xlabel("Model Year",fontsize=14)
plt.ylabel("Frequency",fontsize=14)
plt.title("Number of Audi sold by Model Year",fontsize=14)
plt.grid(linestyle='--', color='gray', alpha=0.5)
plt.show()
```



In [110…
```
audi.model.value_counts()
```

Out[110]:
```
E-TRON               781
A3                   567
Q5 E                 480
E-TRON SPORTBACK     165
Q5                   141
E-TRON GT             73
RS E-TRON GT          16
A7                    11
Q4                    10
A8 E                   3
Name: model, dtype: int64
```

In [157…
```
plt.style.use('dark_background')
plt.figure(figsize=(15,6))
audi.model.value_counts().plot.bar(color="green")
plt.grid(linestyle='--', color='gray', alpha=0.8)
plt.xlabel("Audi Model")
plt.ylabel("Frequency Count")
plt.show()
```

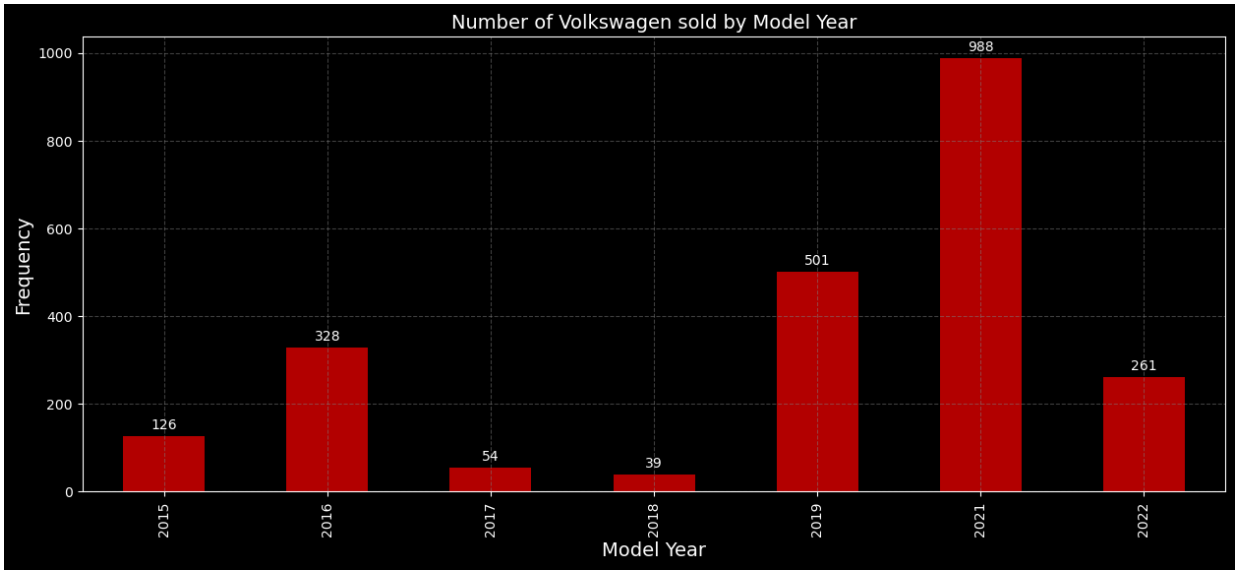


17. VOLKSWAGEN CAR CHART

In [112…
```
volkswagen.model_year.value_counts()
```

Out[112]:
```
2021    988
2019    501
2016    328
2022    261
2015    126
2017     54
2018     39
Name: model_year, dtype: int64
```

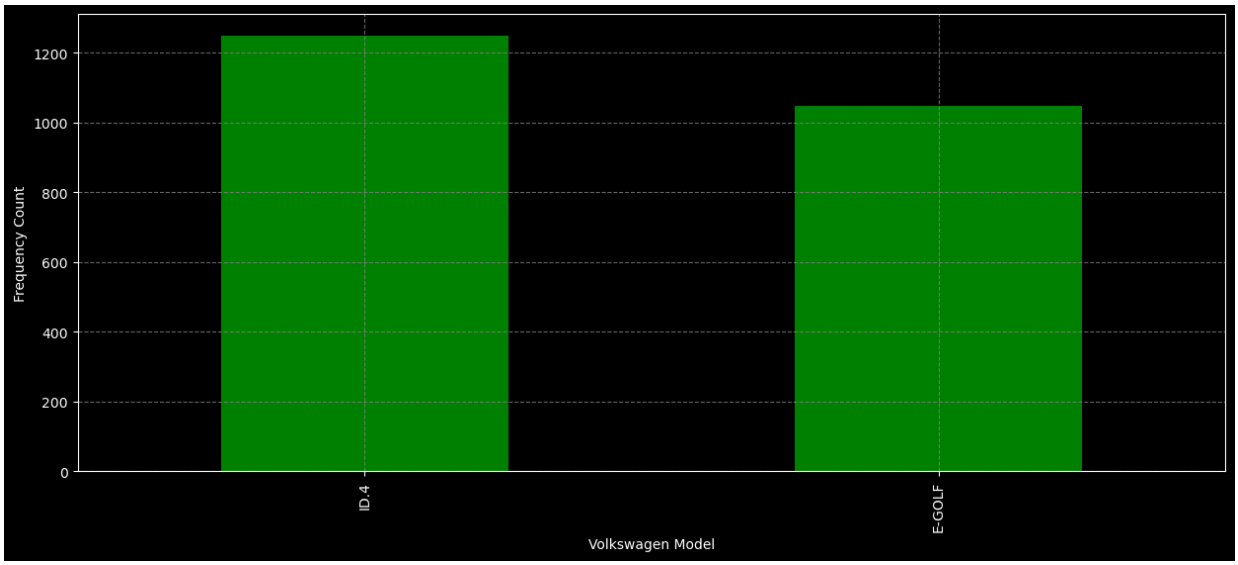
In [113…
```
plt.style.use('dark_background')
plt.figure(figsize=(15,6))
ax = volkswagen.model_year.value_counts().sort_index().plot.bar(color="re

for bar in ax.patches:
    height = bar.get_height()
    ax.annotate(f'{height}',
                xy=(bar.get_x() + bar.get_width() / 2, height),
                xytext=(0, 3),  # 3 points vertical offset
                textcoords="offset points",
                ha='center', va='bottom')
plt.xlabel("Model Year",fontsize=14)
plt.ylabel("Frequency",fontsize=14)
plt.title("Number of Volkswagen sold by Model Year",fontsize=14)
plt.grid(linestyle='--', color='gray', alpha=0.5)
plt.show()
```



In [114…
```
volkswagen.model.value_counts()
```

Out[114]:
```
ID.4       1249
E-GOLF     1048
Name: model, dtype: int64
```

In [115…
```
plt.style.use('dark_background')
plt.figure(figsize=(15,6))
volkswagen.model.value_counts().plot.bar(color="green")
plt.grid(linestyle='--', color='gray', alpha=0.8)
plt.xlabel("Volkswagen Model")
plt.ylabel("Frequency Count")
plt.show()
```

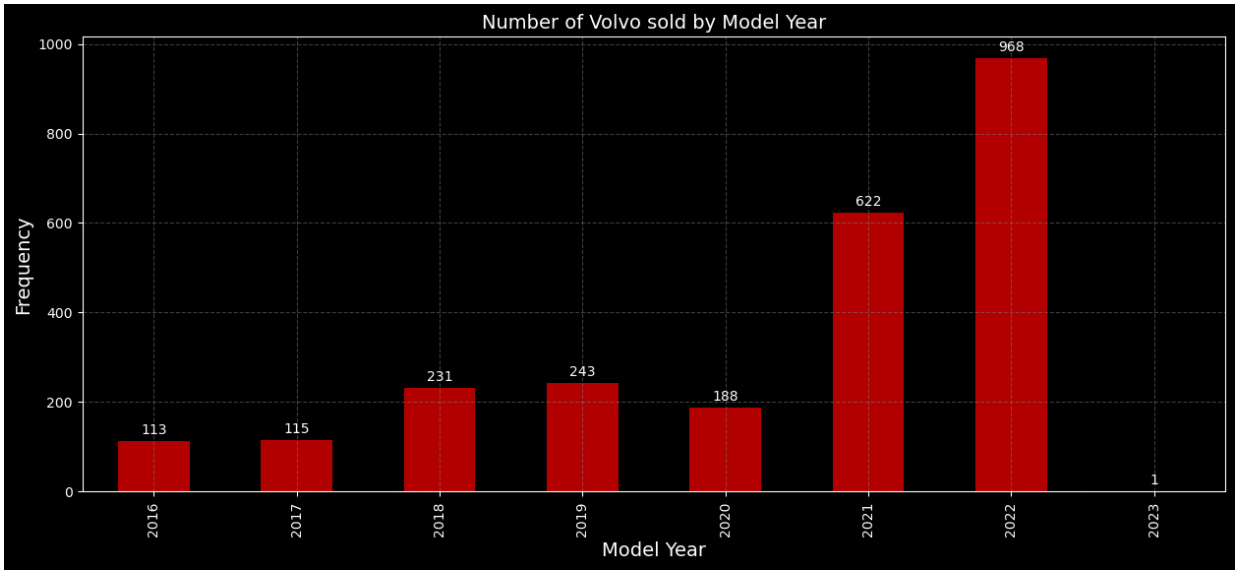


18. VOLVO CAR CHART

In [126…
```
volvo.model_year.value_counts().sort_index()
```

Out[126]:
```
2016    113
2017    115
2018    231
2019    243
2020    188
2021    622
2022    968
2023      1
Name: model_year, dtype: int64
```

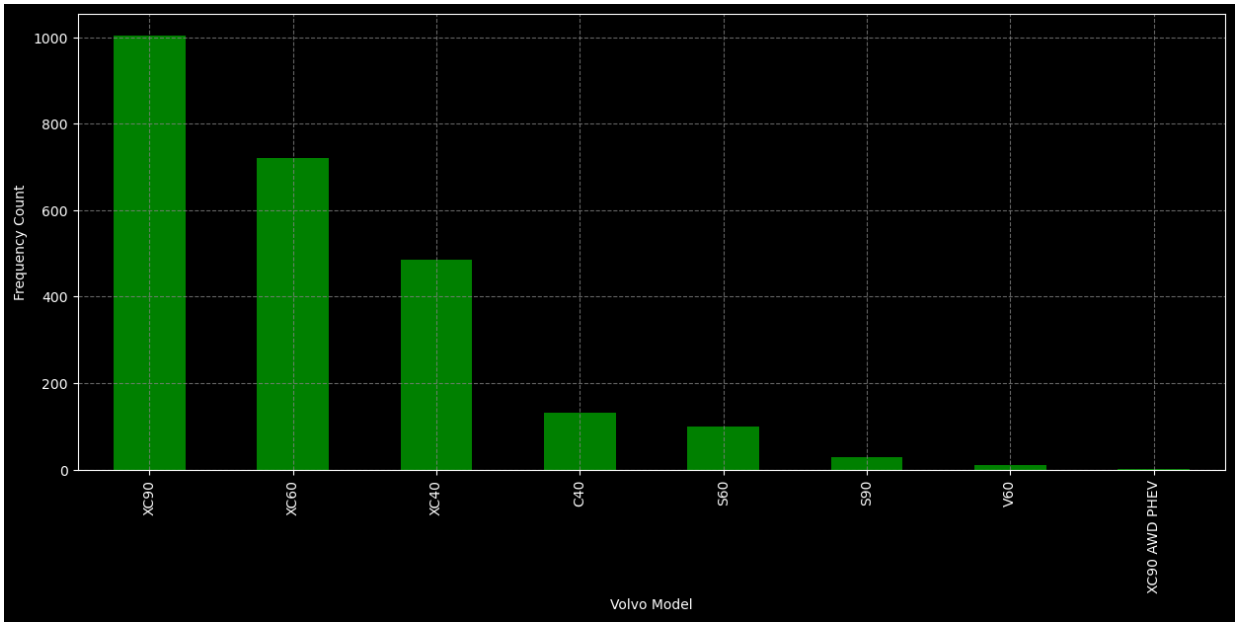
In [127…
```
plt.style.use('dark_background')
plt.figure(figsize=(15,6))
ax = volvo.model_year.value_counts().sort_index().plot.bar(color="red", a

for bar in ax.patches:
    height = bar.get_height()
    ax.annotate(f'{height}',
                xy=(bar.get_x() + bar.get_width() / 2, height),
                xytext=(0, 3),  # 3 points vertical offset
                textcoords="offset points",
                ha='center', va='bottom')
plt.xlabel("Model Year",fontsize=14)
plt.ylabel("Frequency",fontsize=14)
plt.title("Number of Volvo sold by Model Year",fontsize=14)
plt.grid(linestyle='--', color='gray', alpha=0.5)
plt.show()
```



In [128…
```
volvo.model.value_counts()
```

Out[128]:
```
XC90             1005
XC60              721
XC40              485
C40               131
S60                99
S90                29
V60                10
XC90 AWD PHEV       1
Name: model, dtype: int64
```

In [129…
```
plt.style.use('dark_background')
plt.figure(figsize=(15,6))
volvo.model.value_counts().plot.bar(color="green")
plt.grid(linestyle='--', color='gray', alpha=0.8)
plt.xlabel("Volvo Model")
plt.ylabel("Frequency Count")
plt.show()
```

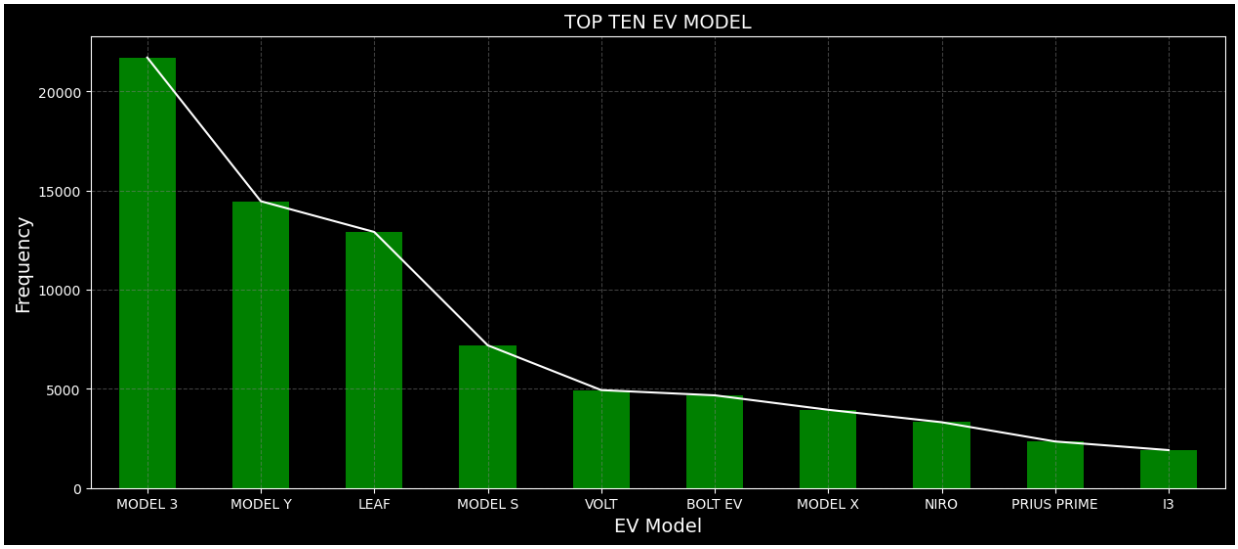


19. TOP TEN ELECTRIC MODEL

In [140…
```
top_5_model = df.model.value_counts().head(10)
top_5_model
```

Out[140]:
```
MODEL 3        21715
MODEL Y        14468
LEAF           12916
MODEL S         7198
VOLT            4938
BOLT EV         4675
MODEL X         3945
NIRO            3318
PRIUS PRIME     2346
I3              1911
Name: model, dtype: int64
```

In [158…
```
top_5_model = df.model.value_counts().head(10)
plt.style.use('dark_background')
plt.figure(figsize=(15,6))
top_5_model.plot.bar(color="green")
top_5_model.plot(color="white")
plt.xlabel("EV Model",fontsize=14)
plt.ylabel("Frequency",fontsize=14)
plt.title("TOP TEN EV MODEL",fontsize=14)
plt.grid(linestyle='--', color='gray', alpha=0.5)
```



1. Model 3 and Model y are top sellin electric cars
2. Nissam Leaf is the third most selling electric car
3. Third Most selling car is Tesla Model S
4. Chevrolet Volt is the fifth most selling electric car
5. Chevrolet Bolt Ev is the six most selling electric car
6. Tesla Model X is the seventh most selling electric car
7. Kia Niro is the eight most selling electric car
8. Toyota Prius prime is the nine most selling electric car
9. BMW I3 is the tenth most selling electric car

20. ELECTRIC CAR SELLING CHART

In [142…
```
df.model_year.value_counts().sort_index()
```

Out[142]:
```
1993        1
1997        1
1998        1
1999        3
2000       10
2002        2
2008       26
2010       26
2011      849
2012     1713
2013     4741
2014     3697
2015     5003
2016     6273
2017     9740
2018    14325
2019    10593
2020    11018
2021    19381
2022    21414
2023      206
Name: model_year, dtype: int64
```

In [143…]
```
df_1993 = df[df["model_year"]==1993]
df_1993
```

Out[143]:

	county	city	state	postal_code	model_year	make	model	electric_
79017	Thurston	Tumwater	WA	98501	1993	DODGE	CARAVAN	B

In [144…]
```
df_1997 = df[df["model_year"]==1997]
df_1997
```

Out[144]:

	county	city	state	postal_code	model_year	make	model	ele
38174	Snohomish	Marysville	WA	98270	1997	CHEVROLET	S-10 PICKUP	

The Chevrolet S-10 Electric was an American electric-powered vehicle built by Chevrolet. It was introduced in 1997, becoming the world's first electric pickup truck from the original manufacturer,[1] updated in 1998, and then discontinued. It was an OEM BEV variant of Chevrolet's S-10 pickup truck. The S-10 Electric was solely powered by electricity (batteries) and was marketed primarily to utility fleet customers.

In [145…]
```
df_1998 = df[df["model_year"]==1998]
df_1999 = df[df["model_year"]==1999]
df_2000 = df[df["model_year"]==2000]
```

In [146…]
```
df_1998
```

Out[146]:

	county	city	state	postal_code	model_year	make	model	electric_vehic
55400	Clallam	Sequim	WA	98382	1998	FORD	RANGER	Battery Vehic

In [147…]
```
df_1999
```

Out[147]:

	county	city	state	postal_code	model_year	make	model	electric_veh
33359	King	Redmond	WA	98052	1999	FORD	RANGER	Batte Veh
47058	Pierce	Graham	WA	98338	1999	FORD	RANGER	Batte Veh
94416	Skagit	Mount Vernon	WA	98274	1999	FORD	RANGER	Batte Veh

In [148…]
```
df_2000
```

Out[148]:

	county	city	state	postal_code	model_year	make	model	electric
9839	King	Shoreline	WA	98133	2000	FORD	RANGER	
11713	Whatcom	Everson	WA	98247	2000	FORD	RANGER	
20048	San Juan	Friday Harbor	WA	98250	2000	FORD	RANGER	
46923	King	Seattle	WA	98117	2000	FORD	RANGER	
56088	King	Shoreline	WA	98133	2000	FORD	RANGER	
58982	Snohomish	Edmonds	WA	98026	2000	FORD	RANGER	
65709	King	Seattle	WA	98136	2000	FORD	RANGER	
79729	San Juan	Waldron	WA	98297	2000	FORD	RANGER	
83674	Whatcom	Everson	WA	98247	2000	FORD	RANGER	
95358	Clark	Vancouver	WA	98686	2000	FORD	RANGER	

The Ford Ranger EV (Electric Vehicle) is a battery powered compact pickup truck that was produced by the Ford motor company and was Ford's first all-electric production vehicle. It was produced starting in the 1998 model year through 2002 and is no longer in production.

In [149…

```
df_2002 = df[df["model_year"]==2002]
df_2002
```

Out[149]:

	county	city	state	postal_code	model_year	make	model	electric_v
9529	Clallam	Sequim	WA	98382	2002	TOYOTA	RAV4	Ba
87592	King	Sammamish	WA	98075	2002	TOYOTA	RAV4	Ba

The Toyota RAV4 EV is an all-electric version of the popular RAV4 SUV produced by Toyota until 2014. Two generations of the EV model were sold in California, and to fleets elsewhere in the US.

In [150…

```
df_2008 = df[df["model_year"]==2008]
df_2008.shape
```

Out[150]:

```
(26, 14)
```

In [151…
```
df_2008[:5]
```

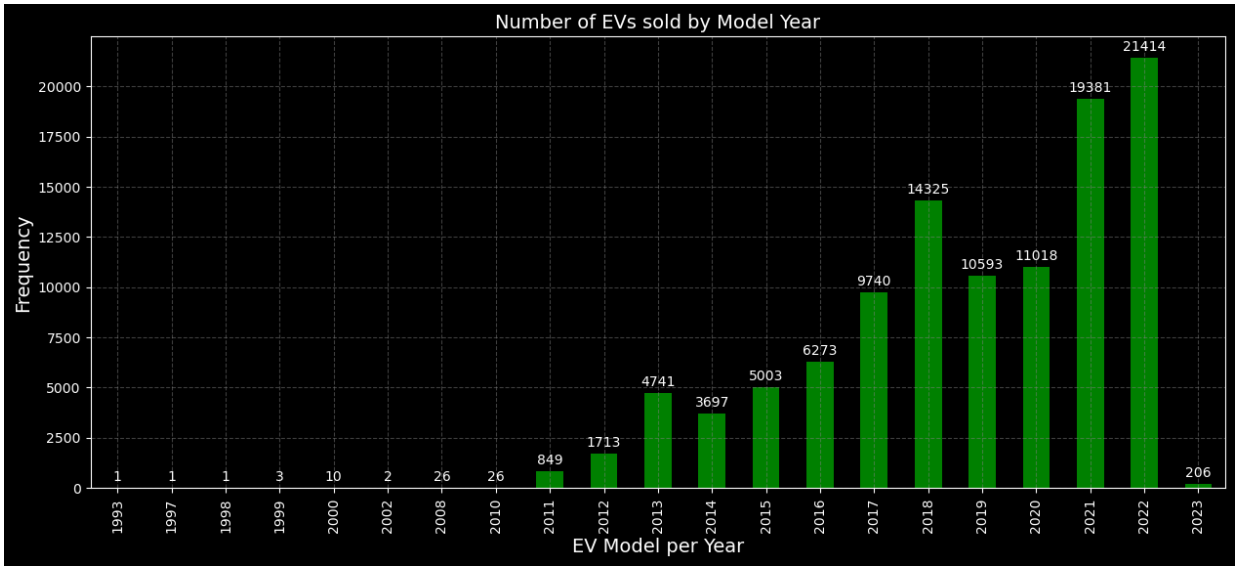
Out[151]:

	county	city	state	postal_code	model_year	make	model	electri
3518	King	Issaquah	WA	98029	2008	TESLA	ROADSTER	
8037	King	Kirkland	WA	98033	2008	TESLA	ROADSTER	
9146	San Juan	Friday Harbor	WA	98250	2008	TESLA	ROADSTER	
13160	King	Redmond	WA	98052	2008	TESLA	ROADSTER	
17412	Snohomish	Brier	WA	98036	2008	TESLA	ROADSTER	

The Tesla Roadster is a battery electric vehicle (BEV) sports car, based on the Lotus Elise chassis, that was produced by the electric car firm Tesla Motors (now Tesla, Inc.) in California from 2008 to 2012. The Roadster was the first highway legal serial production all-electric car to use lithium-ion battery cells and the first production all-electric car to travel more than 320 kilometres (200 mi) per charge.

TOTAL EV CAR SOLD ON UNITED STATE

In [159…
```
plt.style.use('dark_background')
plt.figure(figsize=(15,6))
ax = df.model_year.value_counts().sort_index().plot.bar(color="green")

for bar in ax.patches:
    height = bar.get_height()
    ax.annotate(f'{height}',
                xy=(bar.get_x() + bar.get_width() / 2, height),
                xytext=(0, 3),  # 3 points vertical offset
                textcoords="offset points",
                ha='center', va='bottom')

plt.xlabel("EV Model per Year",fontsize=14)
plt.ylabel("Frequency",fontsize=14)
plt.title("Number of EVs sold by Model Year",fontsize=14)
plt.grid(linestyle='--', color='gray', alpha=0.5)
plt.show()
```



In 2022, EV sold were around 21,414 on records. it is the massive transition of car sold in United State.

In [160…

```
print("Total car sold in United State:", sum(df.model_year.value_counts())
```

```
Total car sold in United State: 109023
```