Descriptive analysis of NYSERDA Electric Vehicle Drive Clean Rebate Program

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Background / Motivation

- With the increasing levels of pollution and depleting resources of fossil fuels, the Electric Vehicle is the need of the hour. The outlook for electric vehicles is brighter than ever. With governments aiming for net-zero carbon emissions, which require no carbon to be emitted, by 2050 they must do more to encourage the usage of electric vehicles.

- NYSERDA offers information and analysis, programs, technical expertise, and funding aimed at helping New Yorkers increase energy efficiency, save money, use renewable energy, and reduce their reliance on fossil fuels.

Data-set Source

- https://data.world/data-ny-gov/thd2-fu8y/workspace/project-summary?agentid=data-ny-gov&datasetid=thd2-fu8y

QR Code

Dataset Description

- The analysis will be based on the dataset: NYSERDA Electric Vehicle Drive Clean Rebate Data: Beginning 2017 obtained from data.world.com.

- The data set represents the initiative by New York State Energy Research and Development Authority (NYSERDA), that offers a rebate for new Electric Vehicle (EV) purchases or leases.

- The data consists of car manufacturers who are part of the program, and the rebate they offer depending on the vehicle model and EV type.

- The data is grouped by the EV types: BEV (Battery EV) and PHEV(Poly-Hybrid EV), and Transaction type: Purchase and Lease.

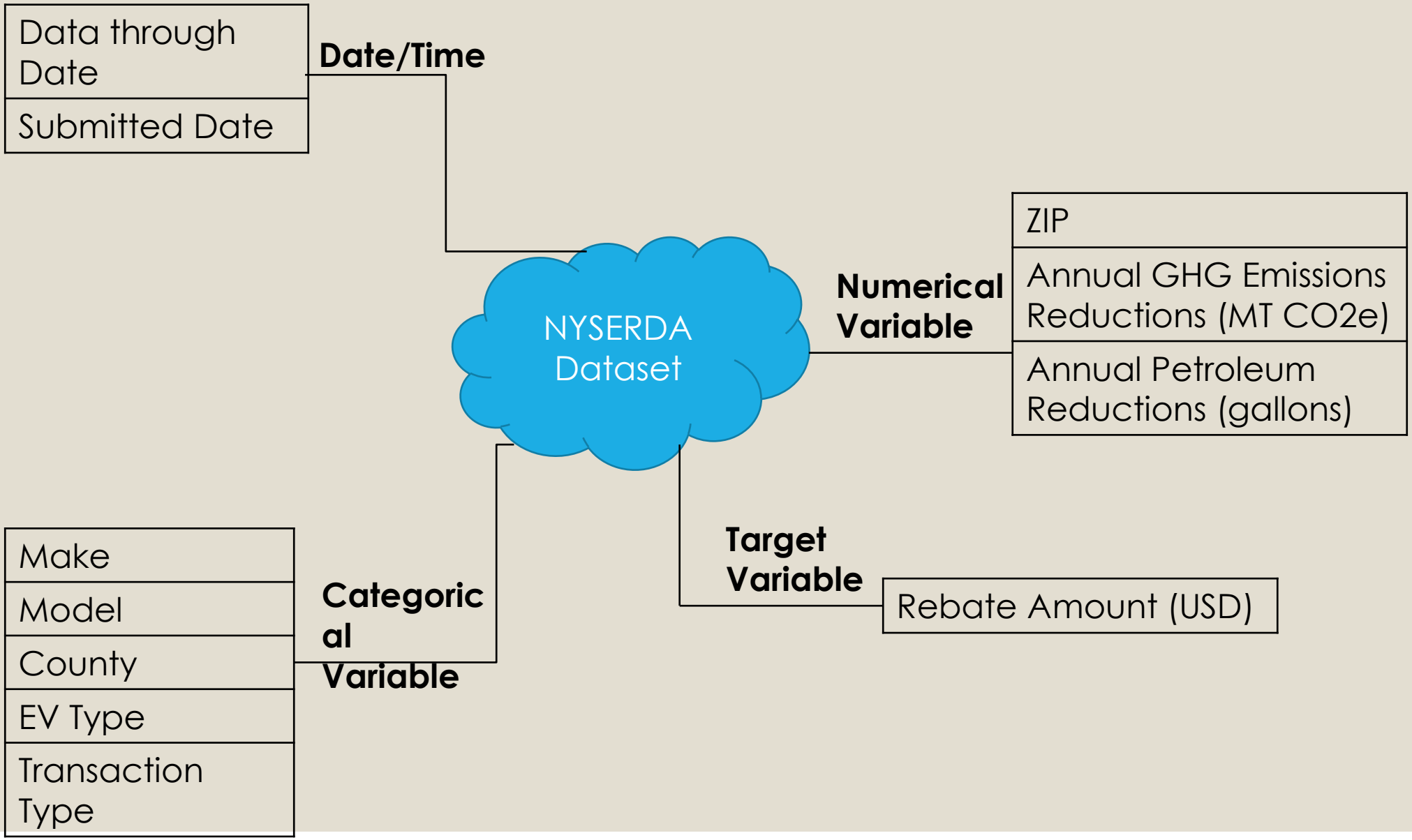
- The dataset contains records from the year 2017 to 2020.

- The data was collected by NYSERDA based on rebate applications submitted by the dealers enrolled in the program.

Variable Details

COLUMN NAME	DESCRIPTION	TYPE	VAR TYPE
data_through_date	The date when the dataset was extracted.	Data	numerical
submitted_date	The date on which rebate applications submitted by the dealers to NYSERDA.	Data	numerical
make	The manufacturer of the vehicle.	String	categorical
model	The models designed by manufacturer.	String	categorical
county	The region where the consumer resides.	String	categorical
zip	ZIP code of region	Integer	nominal
ev_type	Category of electric vehicle- BEV(Battery EV) or PHEV(Poly-Hybrid EV).	String	categorical
transaction_type	Describes whether the vehicle was purchased or taken on lease.	String	categorical
annual_ghg_emissions_reductions_mt_co2e	Reductions in metric tonnes of CO2 emissions annually	Decimal	numerical
annual_petroleum_reductions_gallons	Reductions in gallons of petroleum usage annually	Decimal	numerical
rebate_amount_usd	Amount offered as rebate to the consumer at the time of purchase/lease of EV.	Integer	numerical

Data Description



Problem Statement

- The data set will be helpful to researchers and the government in analysing the reduction in the use of petroleum and C02 emissions due to the use of Electric vehicle.

- It also tackles the issue of cost. It will gladden New Yorkers that they can save money and get a rebate amount of $500 and more, use renewable energy, and accelerate economic growth with electric vehicles.

Project Proposal

- ✓ This project will create a descriptive analytics product to examine outcome of the rebate program to not only help governments encourage residents to transition to EV's, but also help the residents to save energy, money and contribute towards the environment.

Analysis Questions

1. Is the rebate program successful in motivating the consumers to buy fuel efficient cars?

2. Which vehicle type is more popular over the years: BEV or PHEV?

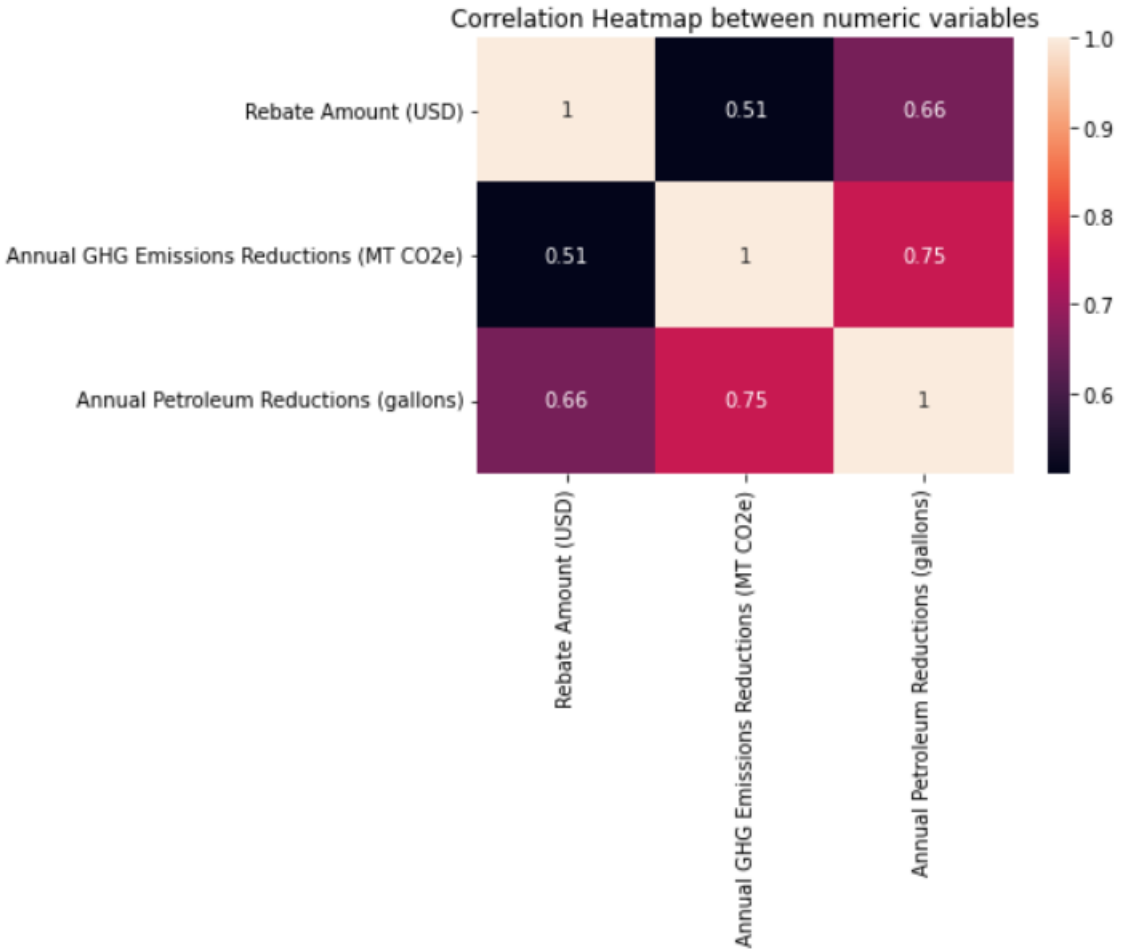
3. Which Make offers wide variety of Models of Electric vehicles?

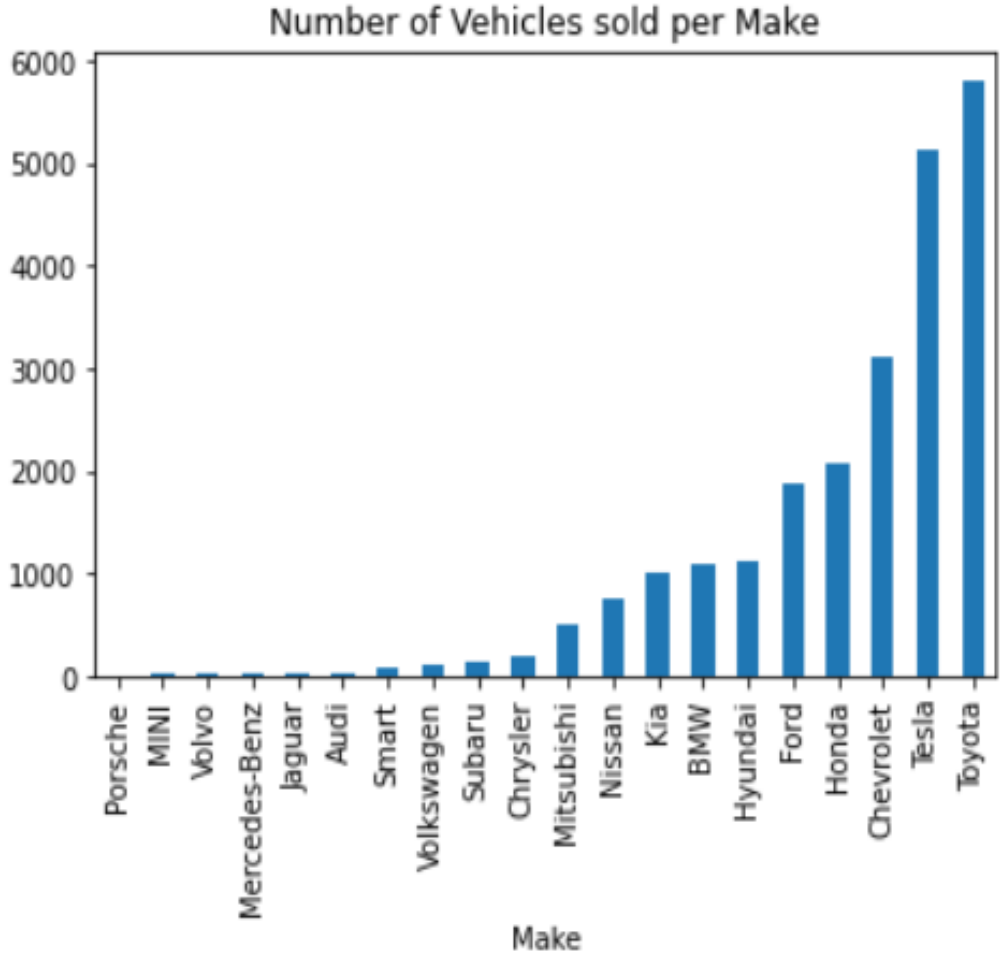
4. What combination of Transaction & EV type lead to maximum Annual Petroleum reduction in given years?

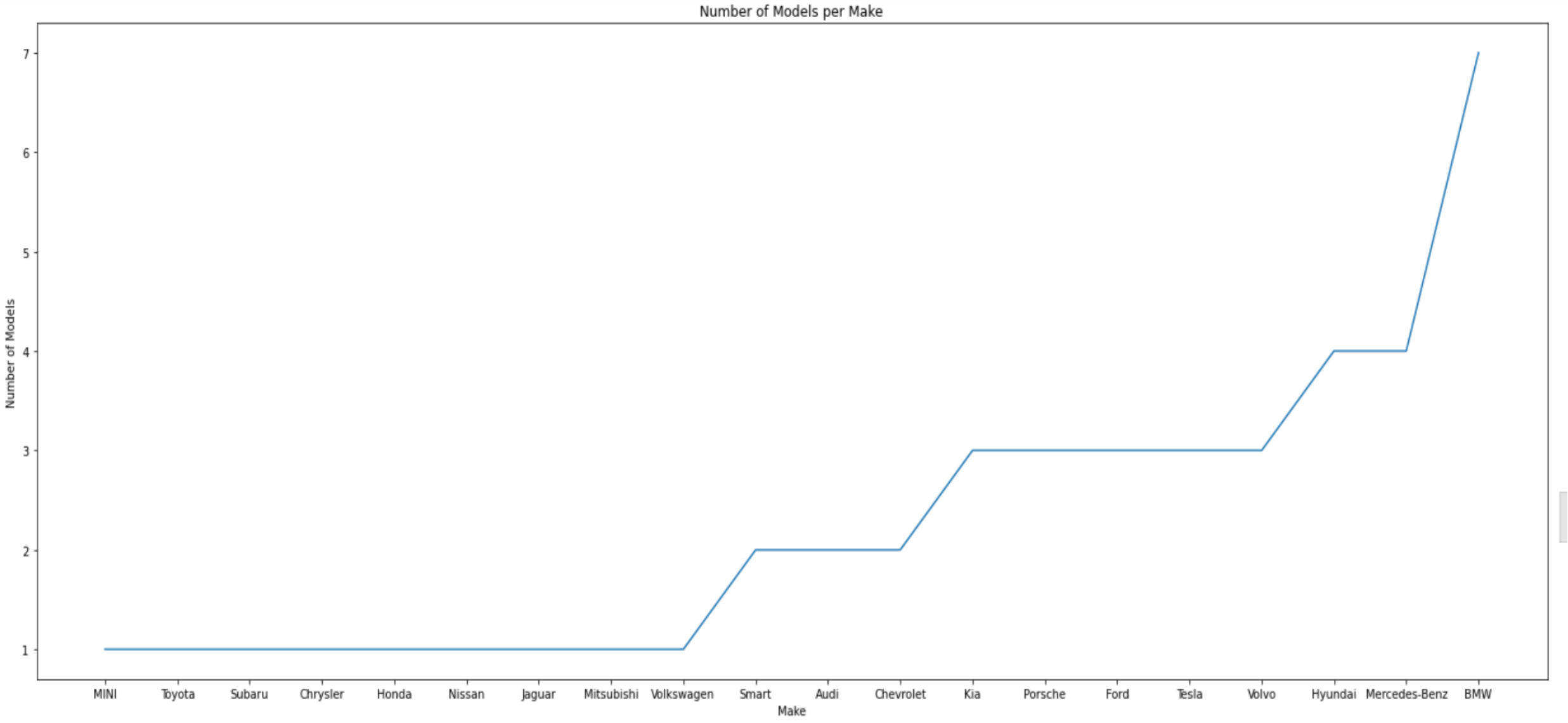
5. Which are the top three car manufacturers with highest sales by EV type?

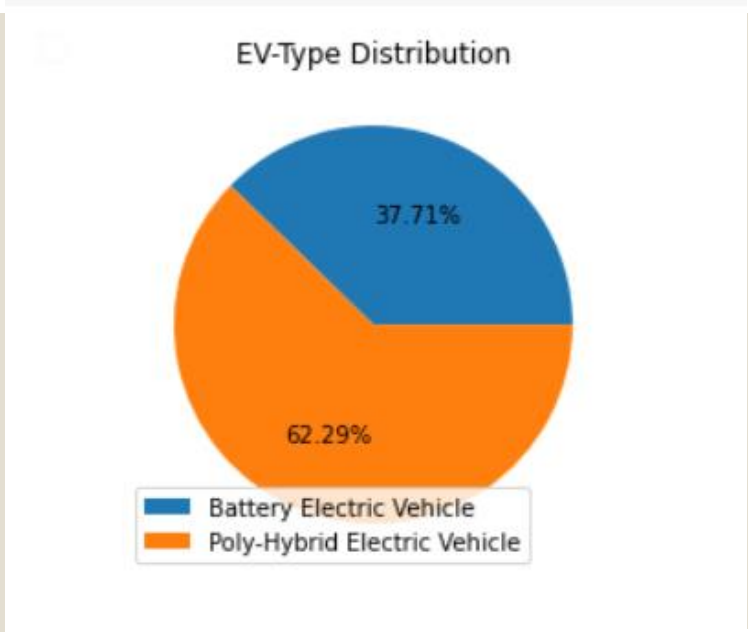
6. Which County has recorded the least sales in the data?

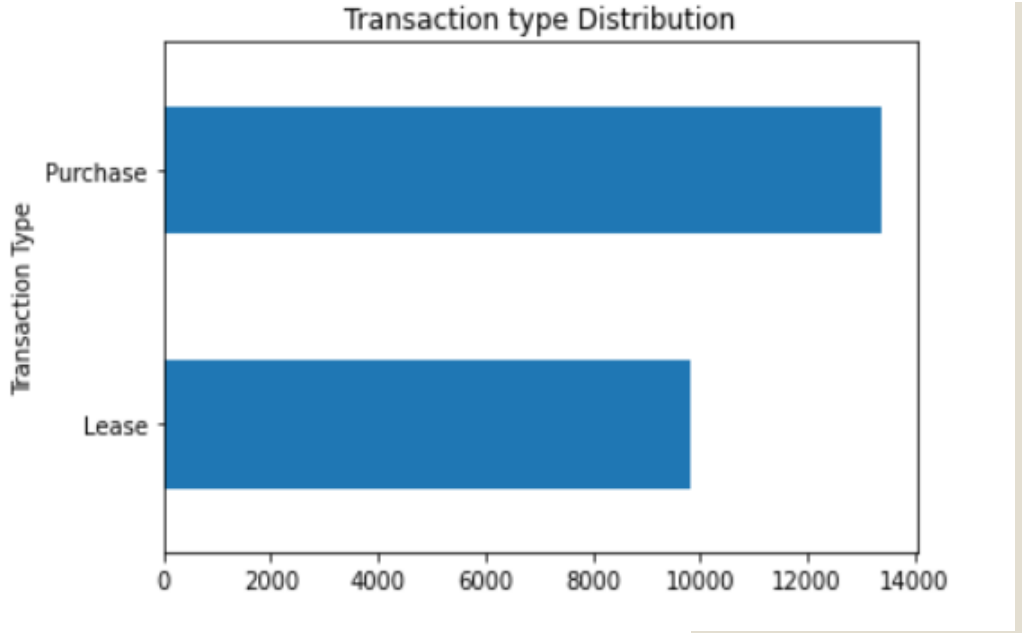
Visualizations to Describe Variables

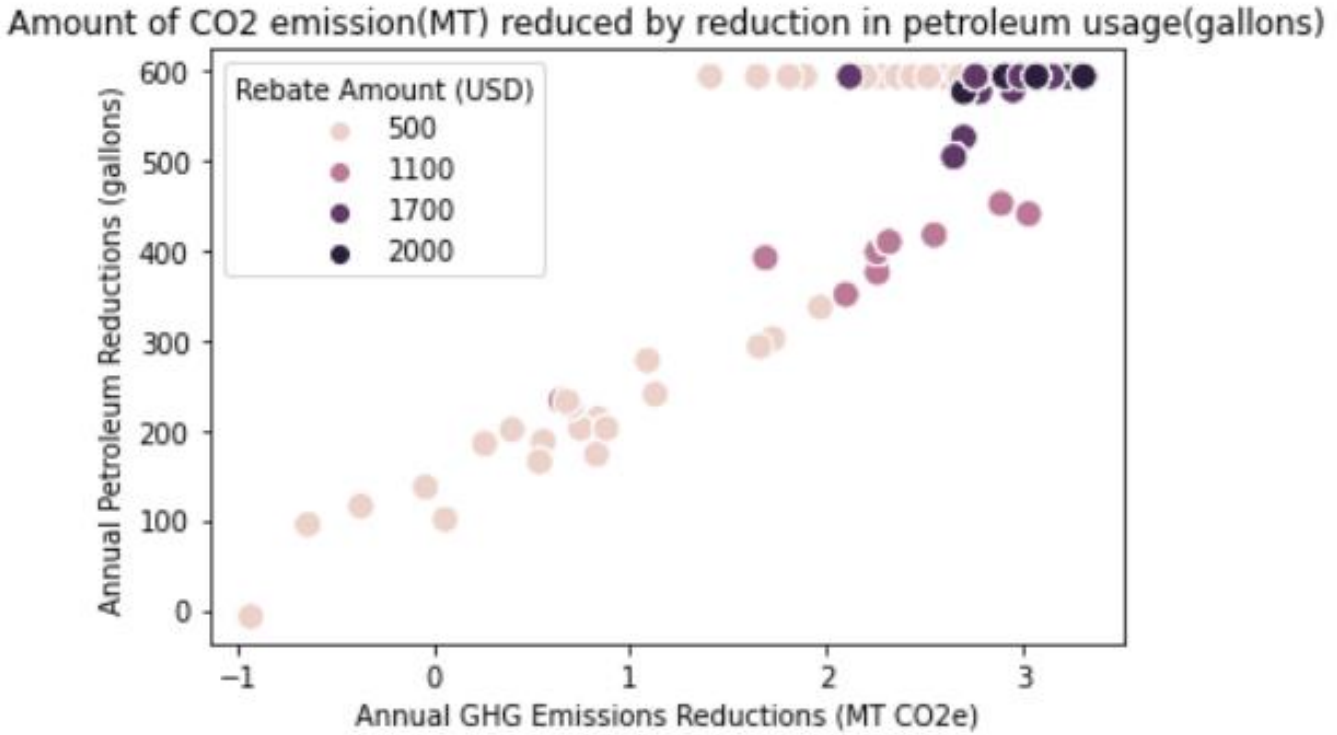

Correlation Heatmap between numeric variables
Rebate Amount (USD)
Annual GHG Emissions Reductions (MT CO2e)
Annual Petroleum Reductions (gallons)
1
0.51
0.66
0.51
1
0.75
0.66
0.75
1
1.0
0.9
0.8
0.7
0.6
Rebate Amount (USD)
Annual GHG Emissions Reductions (MT CO2e)
Annual Petroleum Reductions (gallons)


Number of Vehicles sold per Make
6000
5000
4000
3000
2000
1000
0
Porsche
MINI
Volvo
Mercedes-Benz
Jaguar
Audi
Smart
Volkswagen
Subaru
Chrysler
Mitsubishi
Nissan
Kia
BMW
Hyundai
Ford
Honda
Chevrolet
Tesla
Toyota
Make


Number of Models per Make
Number of Models
1
2
3
4
5
6
7
MINI
Toyota
Subaru
Chrysler
Honda
Nissan
Jaguar
Mitsubishi
Volkswagen
Smart
Audi
Chevrolet
Kia
Porsche
Ford
Tesla
Volvo
Hyundai
Mercedes-Benz
BMW
Make


EV-Type Distribution
37.71%
62.29%
Battery Electric Vehicle
Poly-Hybrid Electric Vehicle


Transaction type Distribution
Transaction Type
Purchase
Lease
0
2000
4000
6000
8000
10000
12000
14000


Amount of CO2 emission(MT) reduced by reduction in petroleum usage(gallons)
Rebate Amount (USD)
500
1100
1700
2000
Annual Petroleum Reductions (gallons)
600
500
400
300
200
100
0
−1
0
1
2
3
Annual GHG Emissions Reductions (MT CO2e)

Transformation Steps

- The column names will be renamed for ease of use. [1]

- We will extract the year from the ‘Submitted Date’ column. [2]

- The ‘Data through Date’ will be removed as it shows the date when the dataset was created. [3]

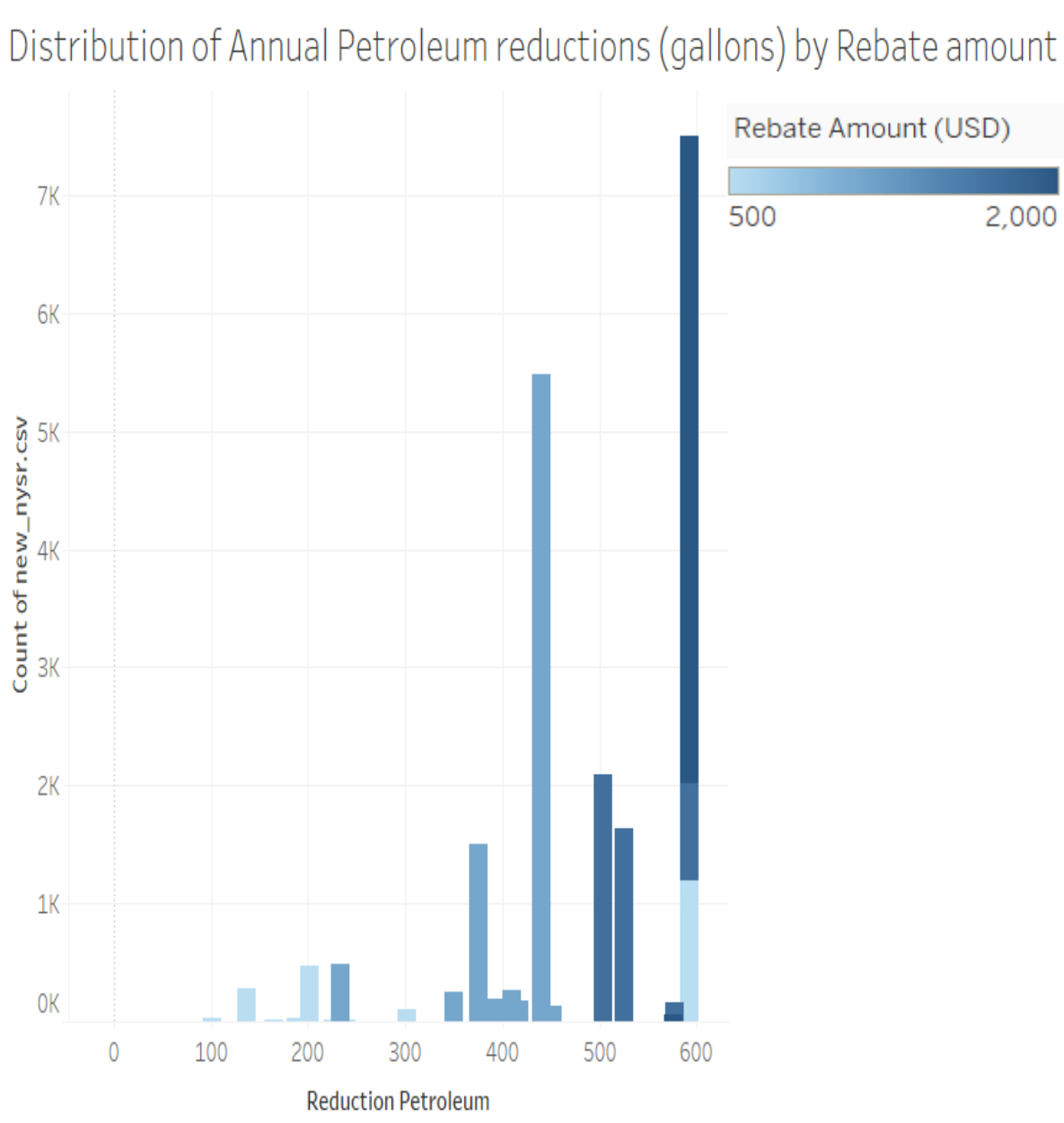
- The records from the year 2020 are only available till the month of February. This leads to data imbalance. Hence for analysis purpose, we will exclude the data from the year 2020. [4]

Answers to Analysis Questions

1. Is the rebate program successful in motivating the consumers to buy fuel efficient cars?

Answer:

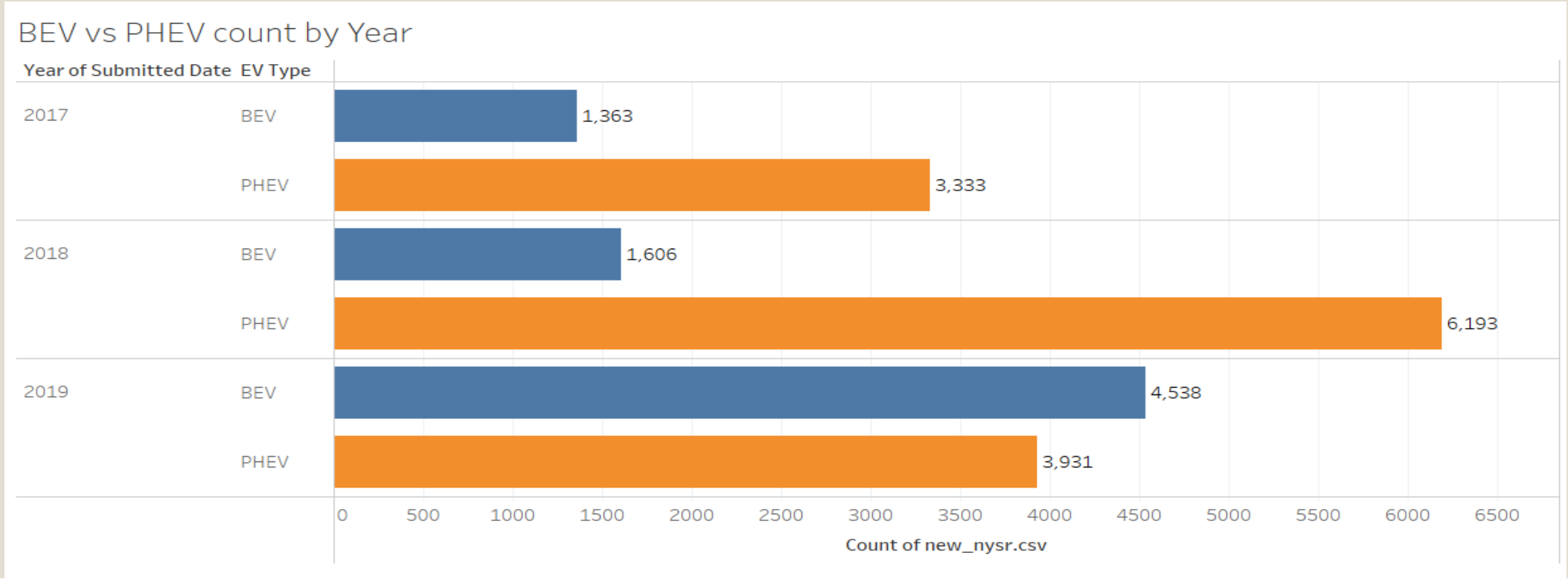
1. For different levels of petroleum reduction, rebate amount offered varies from 500-2000 USD.
2. The rebate program is successful to some extent. It is evident that the number of vehicles sold for higher petroleum reduction is higher which indicates that people are buying fuel efficient cars. But on the other hand the rebate amount cannot be considered as the sole motivating factor for consumers to buy fuel efficient cars because of the following reasons:
   - For petroleum reduction between 230 to 450 gallons, the rebate amount offered is the same i.e. 1100 USD, but it is evident that there are higher number of observations for higher value of petroleum reduction.
   - The number of observations with petroleum reduction between 440-450 is higher than that with reduction values between 500-525 gallons, although the rebate amount is lesser for the former.



2. Which vehicle type is more popular over the years: BEV or PHEV?

Answer:
PHEV is the popular choice in the year 2017 and 2018, however the BEV vehicle type takes over in the year in 2019.

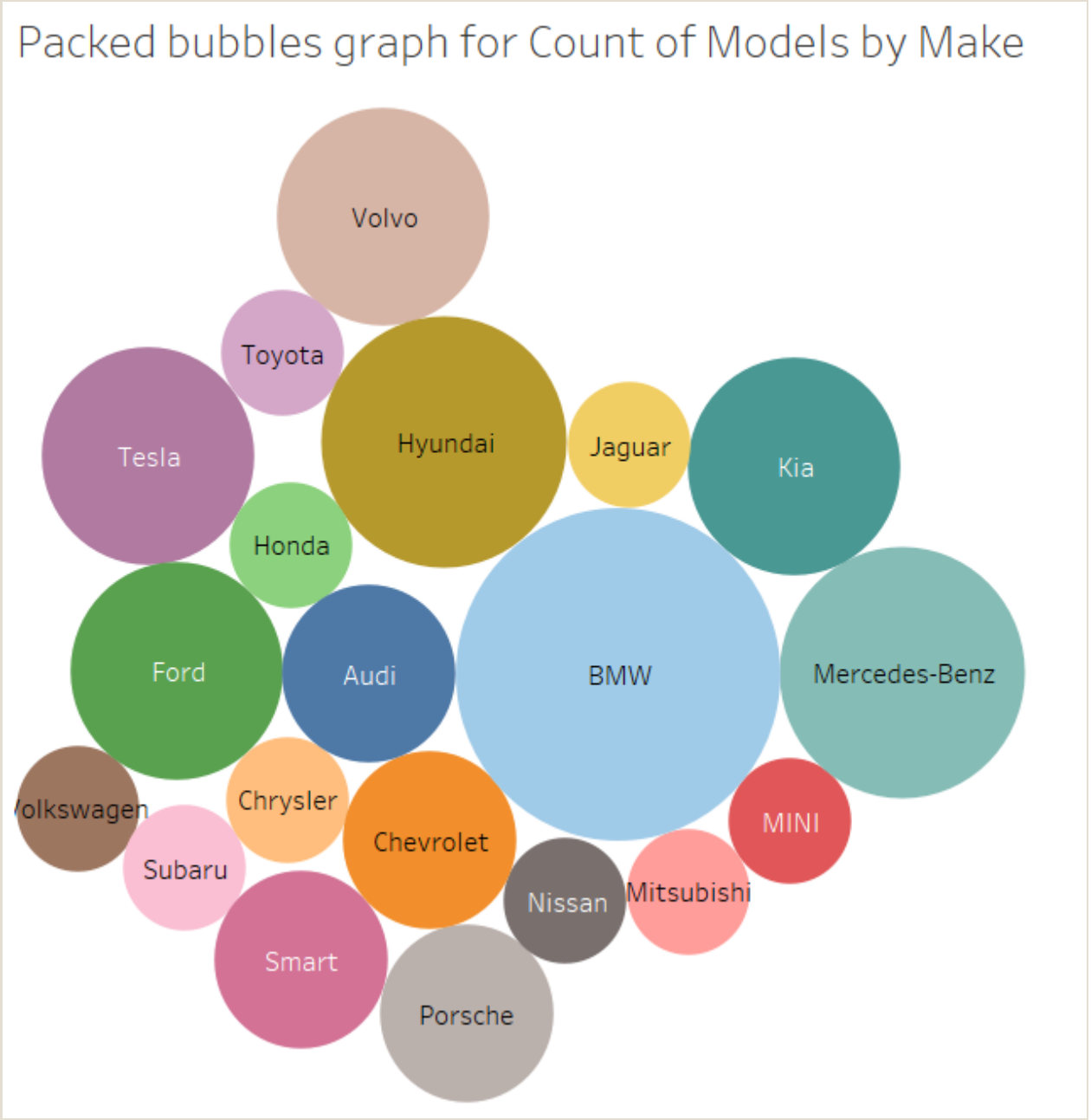
Key insights:
1. The number PHEV vehicles sold has almost doubled from the year 2017 to 2018.
2. The number of BEV vehicles sold has increased three times in 2019 as compared to the previous years.



3. Which Make offers wide variety of Models of Electric vehicles?

Answer:
BMW has the highest number of models with the count of distinct models being 7.

Key insights:
1. Hyundai and Mercedes-Benz are the upcoming competitors with a count of 4 models each.



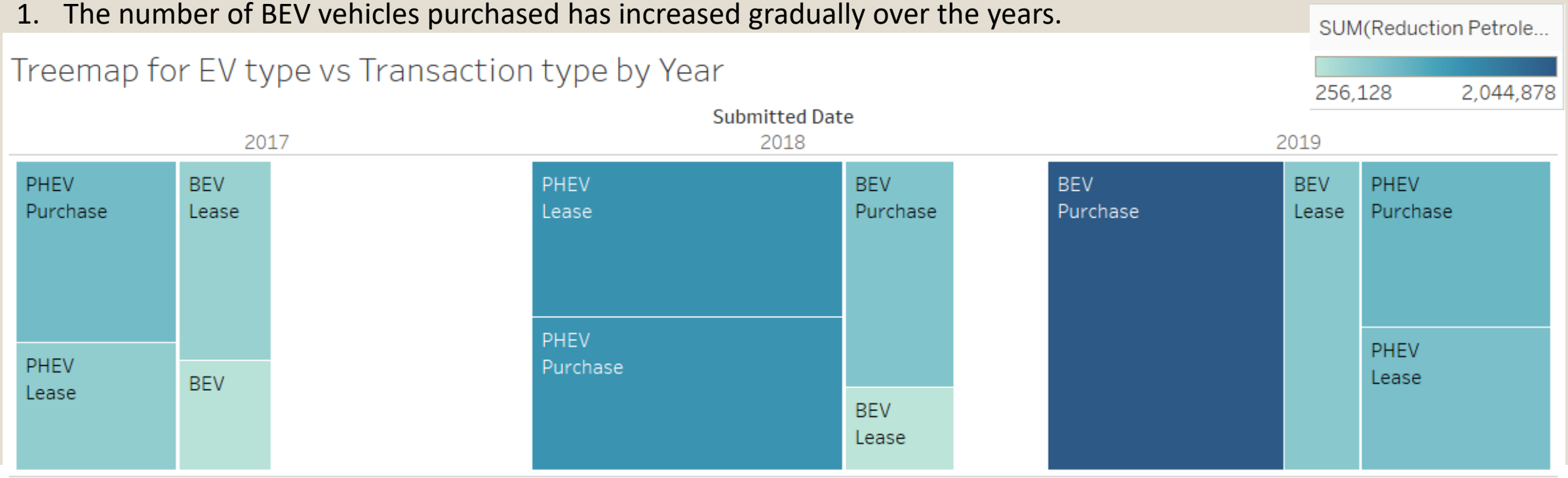
4. What combination of Transaction & EV type lead to maximum Annual Petroleum reduction in given years?

Answer:

- In 2017 the combination of PHEV vehicle type and Purchase as transaction type led to maximum Annual Petroleum reduction.
- In 2018 the combination of PHEV vehicle type for both transaction types: Purchase and Lease, led to maximum Annual Petroleum reduction.
- In 2019 the combination of BEV vehicle type and Purchase as transaction type led to maximum Annual Petroleum reduction.

Key insights:

1. The number of BEV vehicles purchased has increased gradually over the years.



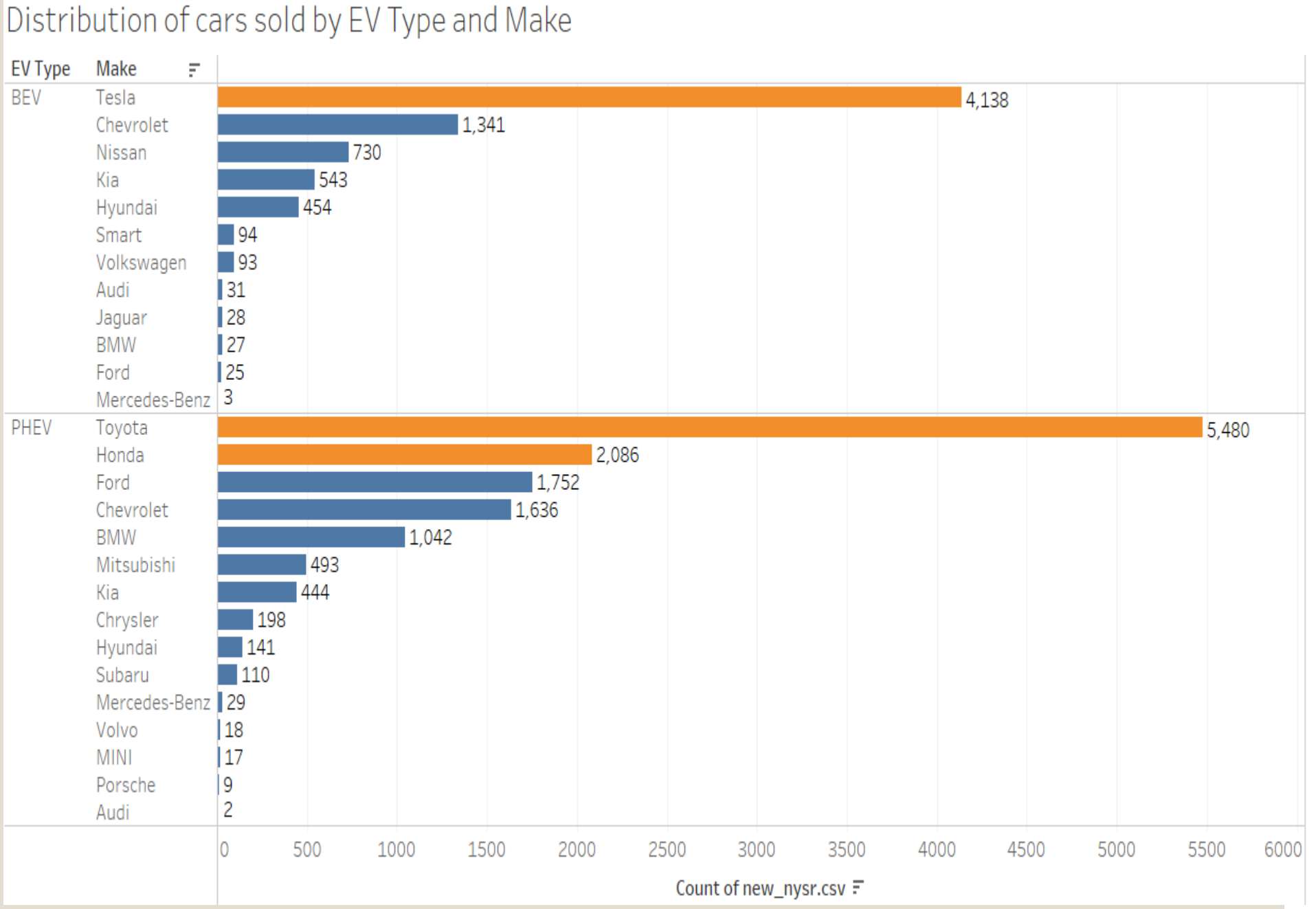
5. Which are the top three car manufacturers with highest cars sold by EV type?

Answer:

- The PHEV Toyota has the highest cars sold overall, followed by the BEV Tesla and the PHEV Honda.

Key insights:

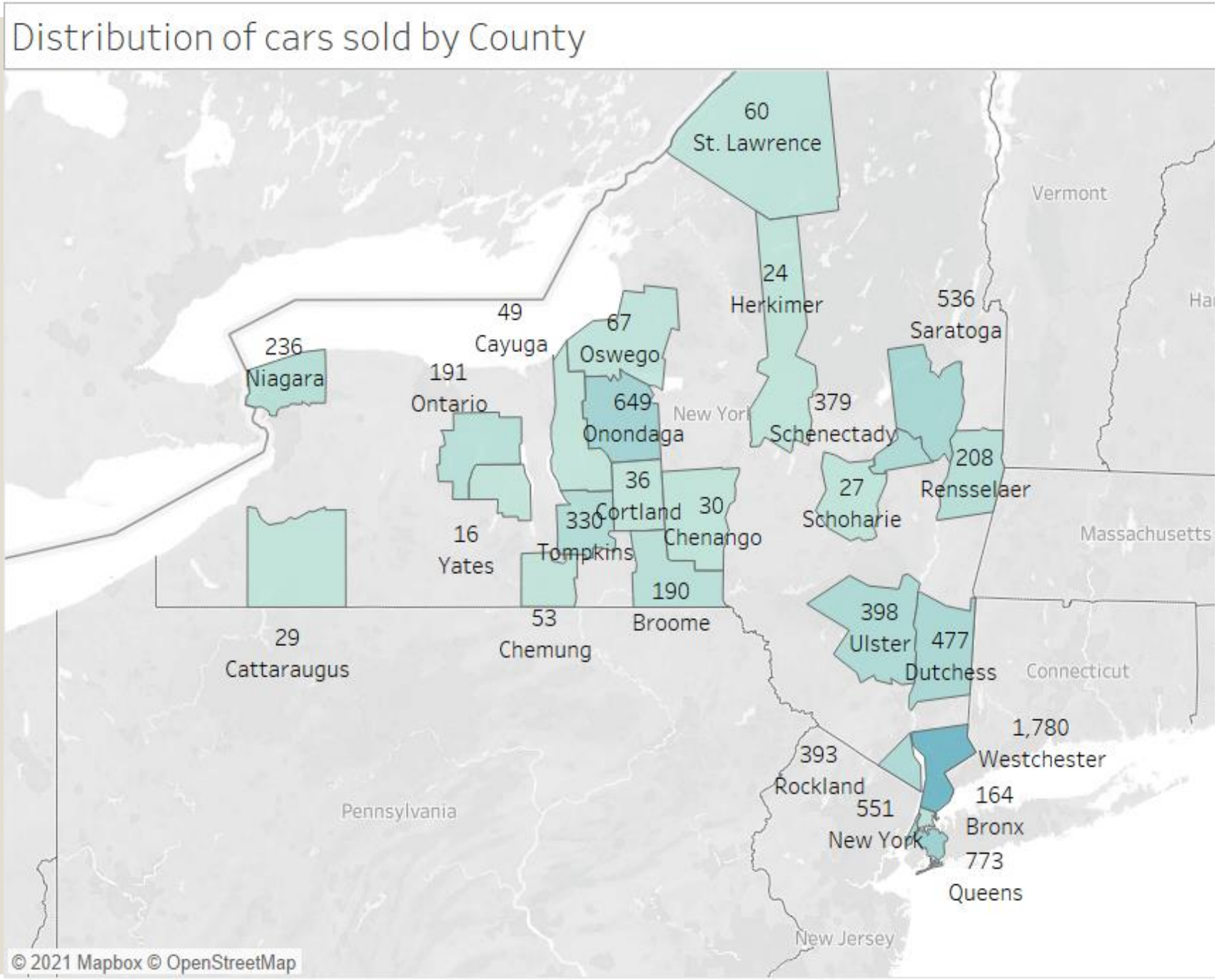
1. The number of cars sold for Mercedes-Benz and Audi is the least in BEV and PHEV vehicle types respectively.
2. Overall number of cars sold for PHEV is greater than BEV.



6. Which County has recorded the least sales in the data?

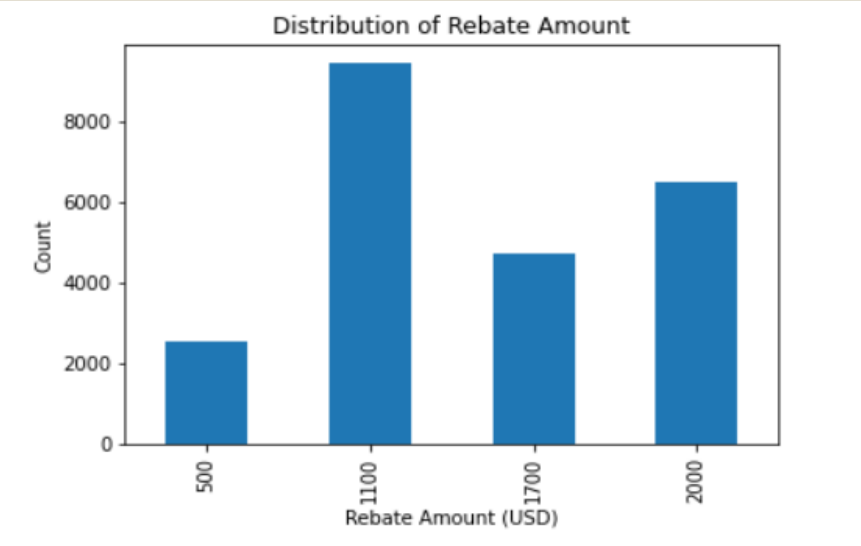
Answer:
The count of cars sold in Yates county is 20 which is the least among the rest of the counties.

Key insights:
1. The counties with larger geographic area like St. Lawrence and Herkimer have lower number of cars sold as compared to the smaller counties like Westchester, Queens and New York. This indicates there are other factors determining the sale of EV's for example presence of a wide network of charging stations and size of the population.

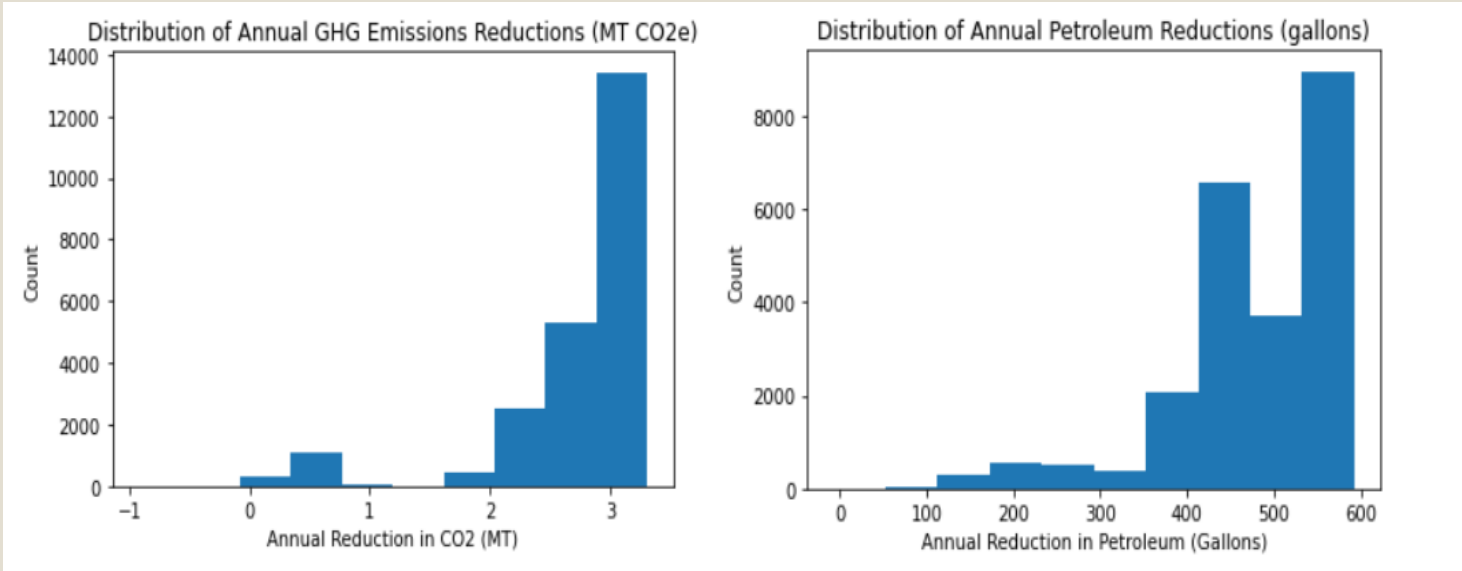


Feedback acknowledged from Submission 1

Segmentation of data:
The data can be segmented based on the target variable - Rebate Amount.



Determining presence of Outliers and Anomalies:
As there is no outlier observed in the distribution, we can say there is no unusual pattern observed from the plots.



REFERENCE for Transformation Steps

[1] https://pandas.pydata.org/docs/reference/api/pandas.DataFrame.rename.html

[2] https://datascienceparichay.com/article/pandas-split-column-by-delimiter/

[3] https://www.geeksforgeeks.org/change-the-order-of-a-pandas-dataframe-columns-in-python/

[4] https://pandas.pydata.org/docs/reference/api/pandas.to_numeric.html

[5] https://news.gov.bc.ca/releases/2021EMLI0058-001836

Plots –title, calculated field, caption, axis - https://www.tableau.com/support/help

Conclusion

To conclude, the rebate program is successful to some extent –

- It is evident that the number of vehicles sold for higher petroleum reduction is higher which indicates that people are buying fuel efficient cars. But on the other hand the rebate amount cannot be considered as the sole motivating factor for consumers to buy fuel efficient cars.
- PHEV is the popular choice in the year 2017 and 2018, however the BEV vehicle type takes over in the year in 2019.
- The counties with larger geographic area like St. Lawrence and Herkimer have lower number of cars sold as compared to the smaller counties like Westchester, Queens and New York. This indicates there are other factors determining the sale of EV's for example presence of a wide network of charging stations and size of the population.
- Few of the high-end brands of car manufacturers like BWM, Mercedes have contributed to maximum number of models of EV. However, there are other upcoming manufacturers like Jaguar, Porsche who are still emerging in the EV market.
- In 2019 the combination of BEV vehicle type and Purchase as transaction type led to maximum Annual Petroleum reduction.
- Although Toyota has the least number of makes, the count of cars sold by this brand stands on the top
- `Geographical area does not determine the number of cards sold. It depends on the other factors like the number of charging station, the population the running cost and charging cost for EV is cheaper than Fuel vehicles.

Recommendations

Based on the analysis of this dataset, for appreciable reduction in annual emission to be recorded in NYSERDA , the researchers recommends the following:[5]

- Firstly, for a continuous reduction in annual petroleum and increase in the use of electric cars, it is observed that the BEV vehicle type is getting popular in 2019 contributed the most to the maximum annual petroleum reduction in that year. Therefore, it is recommended that there should be more supply and accessibility of BEV vehicle for purchase across the counties in New York.
- For counties with very low sales of electric cars, increase in rebate amount in these specific areas can influence and increase overall purchase and lease of electric vehicles, thereby increasing the annual petroleum reduction as they opt out of petroleum cars to electric cars.
- For NYSERDA to be able to achieve their objective of helping New Yorkers increase energy efficiency, save money, use renewable energy, and reduce their reliance on fossil fuels, they must be ready invest more not only in rebate amount offered but also offer some form of discount or rebate in charging stations. This way you can expect an exponential surge in the use of electric cars.
- For the government to achieve its net-zero carbon emission by 2050, the government in partnership with the NYSERDA should provide and make easily accessible charging stations in New York. Charging stations strategically placed in New York would encourage New Yorkers to go electric. Government can also reduce or make electricity rate cheaper and affordable for those who have a charging station in their homes.

Thank You