

Iron

Fridge

Washer

**Air
Conditioner**

Dryer

Investigating EV charging Data
- Yash Nema

Heater





Agenda

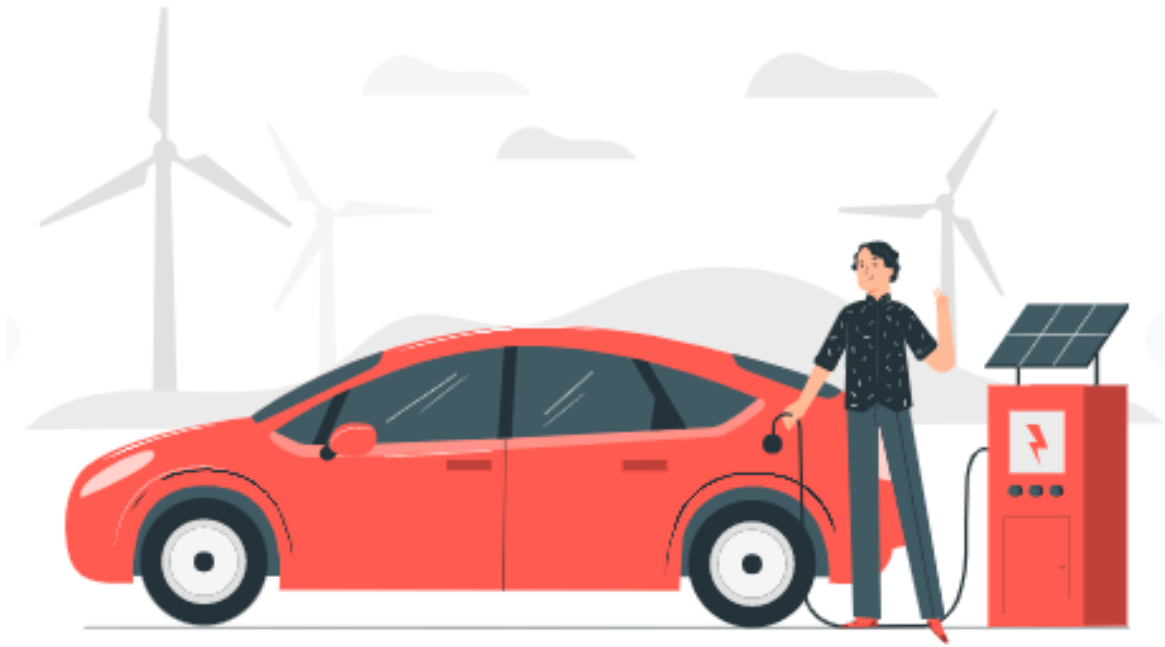
- **Business Objective**
- **Factors impacting EV consumption of a car**
- **Solution - Data Preparation | EV Energy consumption Segments | Modelling Approach**
- **Model Results**
- **Recommendations and Next steps**



Business Objective

Help equip client customers with insights about their EVs energy consumption and help predict future charging behavior

Factors impacting EV consumption of each Household



- **Car model** : Different cars have different battery capacities.

- **Car Utility** : How often the EV is used - for everyday transit to work or to run errands once a week.

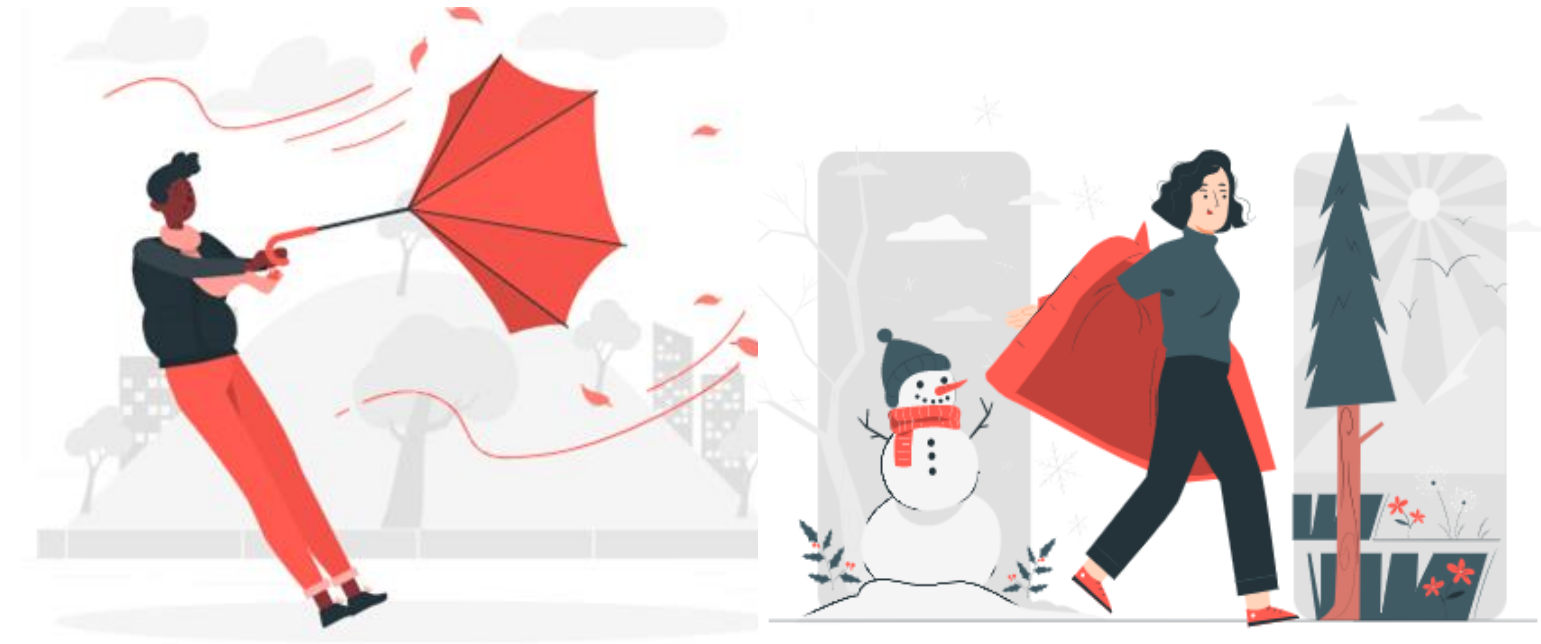


Factors impacting EV consumption of each Household



- **Geo Location** : Accessibility to charging stations in certain areas impacts the usage and charging behavior.

- **Weather** : In winters people would prefer driving than walking or biking. This factor plays a big role in the energy consumption.



Factors impacting EV consumption of each Household



- **Charging Pattern** : Some people may want to charge up to **100 %** and some people may not want to go beyond **50-80%** depending on how much time the car takes to charge , how far they need to go or how often they use their car.

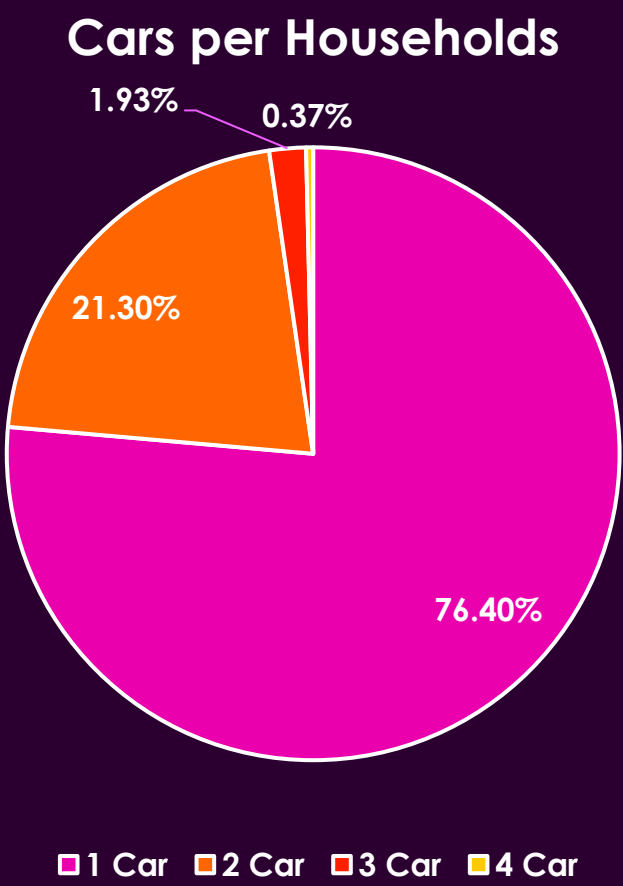
- **Battery Degradation** : Over time the charging pattern, duration of charge and utility of the car changes since the battery quality degrades.



Solution - Data Preparation

Creating Individual Car level dataset

Car_id	House_id	EV_id	State	Zip3	Time	EV
1340_EV0	1340	EV0	CA	910	3/10/2020 0:00	1556.04
1340_EV0	1340	EV0	CA	910	3/10/2020 1:00	389.01
1340_EV0	1340	EV0	CA	910	3/10/2020 2:00	4668.12
1340_EV0	1340	EV0	CA	910	3/10/2020 3:00	2374.57
1340_EV0	1340	EV0	CA	910	10/22/2020 19:00	88.11
957_EV0	957	EV0	KS	661	3/7/2020 22:00	4500.63
957_EV0	957	EV0	KS	661	3/12/2020 21:00	5090.87
957_EV0	957	EV0	KS	661	3/12/2020 22:00	7040.15
957_EV0	957	EV0	KS	661	3/12/2020 23:00	1437.39
957_EV0	957	EV0	KS	661	3/13/2020 0:00	94.31
957_EV0	957	EV0	KS	661	3/19/2020 18:00	5349.17
957_EV0	957	EV0	KS	661	3/19/2020 19:00	7622.90
957_EV0	957	EV0	KS	661	3/21/2020 19:00	3945.62
957_EV0	957	EV0	KS	661	3/21/2020 20:00	7684.80
957_EV0	957	EV0	KS	661	3/21/2020 21:00	7443.02



Car Level Data Preparation

- To be able to analyze individual cars charging pattern, factors impacting the energy consumption
- Columns House id and EV column for the House was concatenated as Car id
- Example: 1340_EV0 is the car id for Household 1340 with 1 EV and data in EV0 column

Solution - Understanding Car Level data

California had the highest number of EV cars that sense was able to monitor, higher adoption could be due to the tech savvy and early adopter nature of the state population and presence of EV Brand Head quarters.

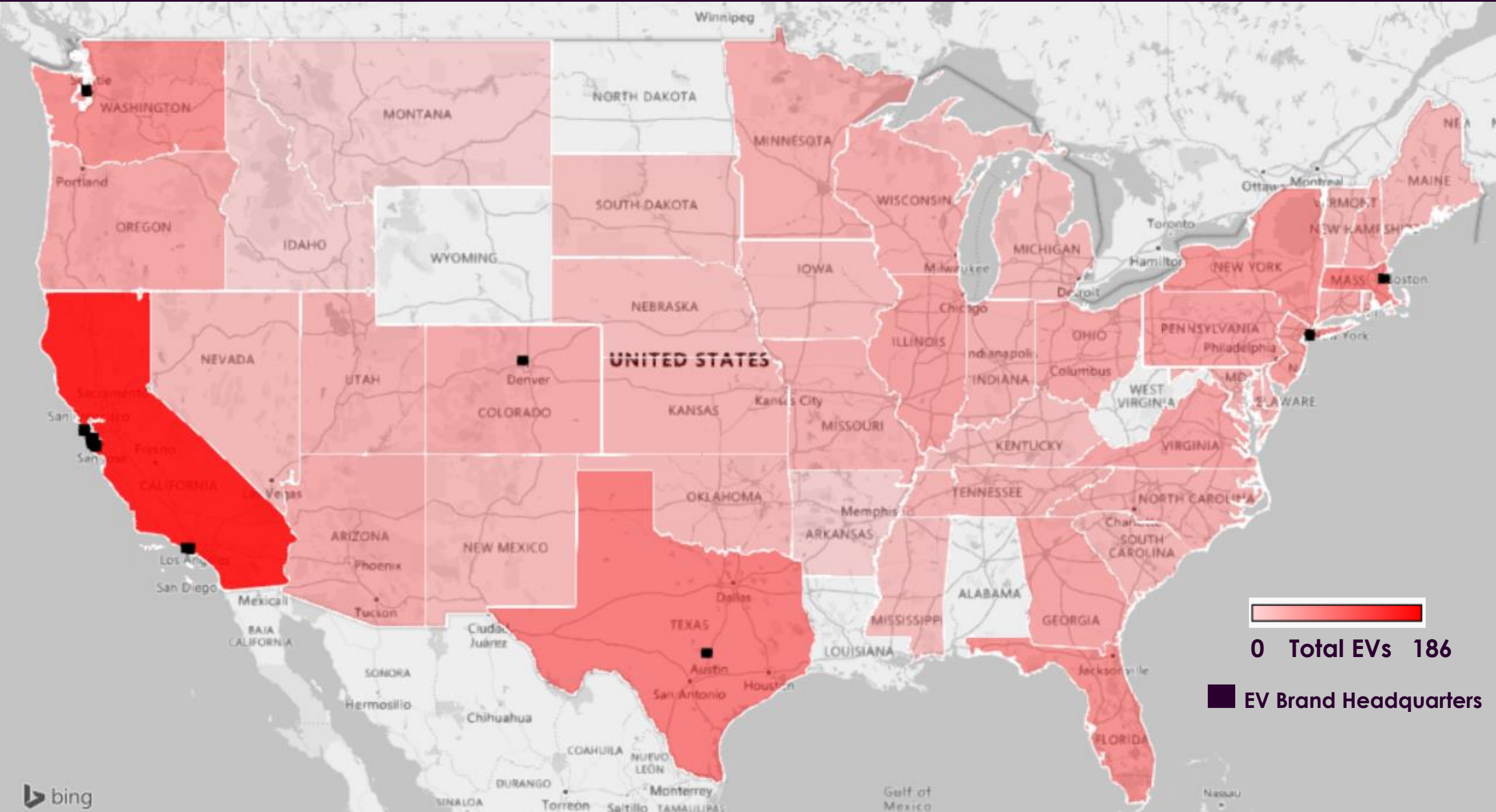


1246 Distinct EVs



45 States

State Name	Total Cars Share(%)	Average EV consumption
California	18%	4375
Texas	7%	4132
Massachusetts	7%	3730
Washington	5%	3415
Florida	5%	4069
New York	4%	4745
New Jersey	4%	4777



EV Energy consumption Segments



High Energy Consumption Segment

Total Users : **330**
Energy Range : **>5600 W**
Average Energy consumption : **6626 W**
Top States : **CA, TX, NY**



High - Mid Energy Consumption Segment

Total Users : **295**
Energy Range : **<5600 W & >4600W**
Average Energy consumption : **5060 W**
Top States : **CA, TX, MA**



Mid - Low Energy Consumption Segment

Total Users : **325**
Energy Range : **<4600 W & >3400W**
Average Energy consumption : **4018 W**
Top States : **CA, MA, TX**



Low Energy Consumption Segment

Total Users : **296**
Energy Range : **<3400 W**
Average Energy consumption : **2297 W**
Top States : **CA, WA, MA**

Recommendation

By utilizing predict algorithms, we can create value based segments to classify new cars added into the ecosystem into the respective segments.

Polynomial regression can then be used to predict new cars future trend.



Deep Dive - EV Energy consumption Segments

High energy consumptions charges for a highest duration during a day but least number of days for the total time period.

1

High Energy Consumption Segment

Average Charging time/day(in Hours):
3.49 Hours/Day

Average Charging Days(%): **25 %** of Total Days charged

Longest duration and least frequent charging

2

High - Mid Energy Consumption Segment

Average Charging time/day(in Hours):
3.30 Hours/Day

Average Charging Days(%): **30 %** of Total Days charged

3

Mid - Low Energy Consumption Segment

Average Charging time/day(in Hours):
3.00 Hours/Day

Average Charging Days(%): **35 %** of Total Days charged

4

Low Energy Consumption Segment

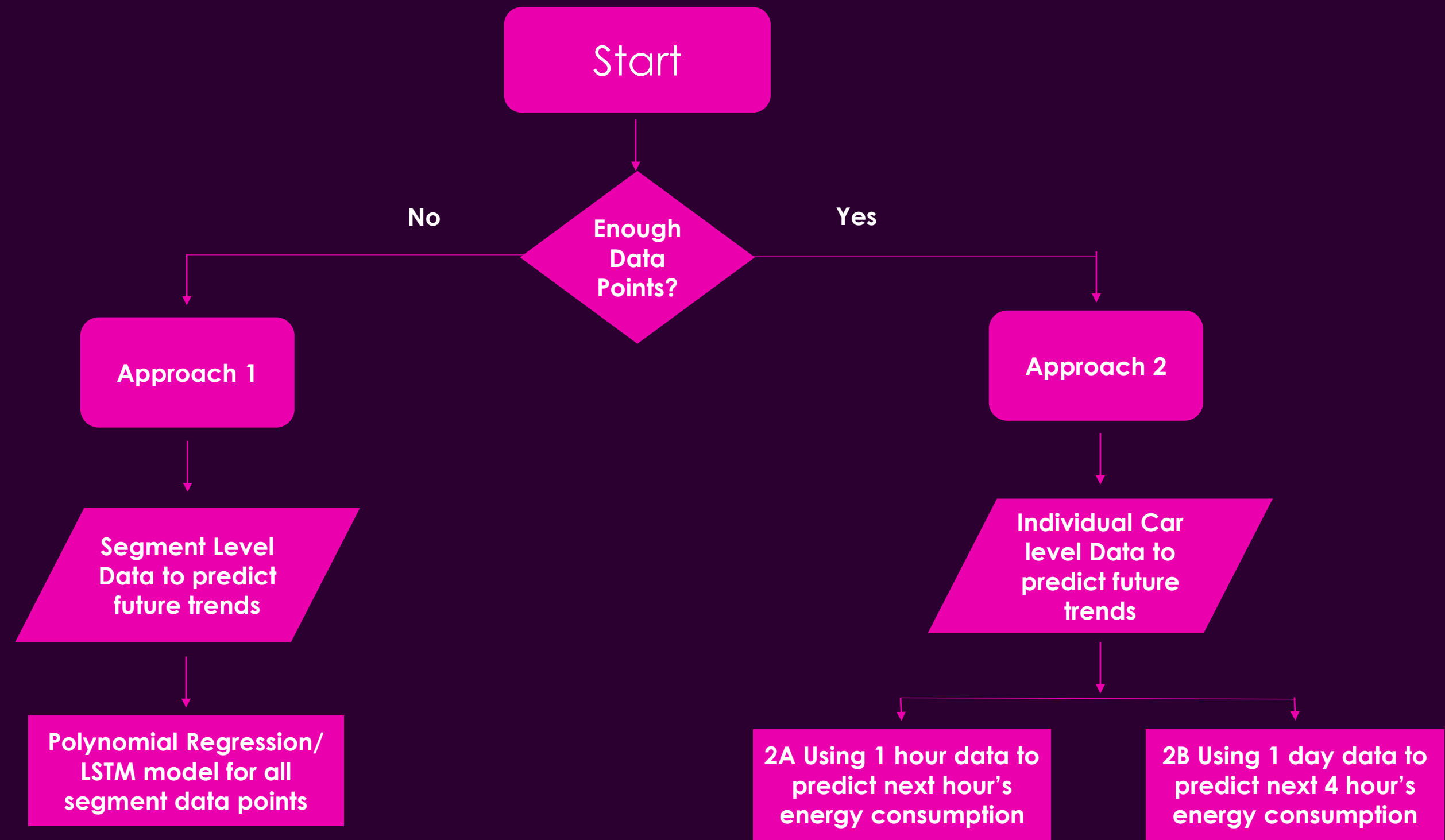
Average Charging time/day(in Hours):
3.46 Hours/Day

Average Charging Days(%): **37 %** of Total Days charged

Slow/low requirement and frequent charging

Modeling Approach

Prediction Steps to be taken



Model Results Summary

LSTM Model Details- Parameters and Results

Predicting 1 hour ahead

X: EV consumption for past hour

Y: EV consumption after 1 hour

Predicting 4 hour ahead

X: Total EV consumption for every 4 hours for past 24 hours

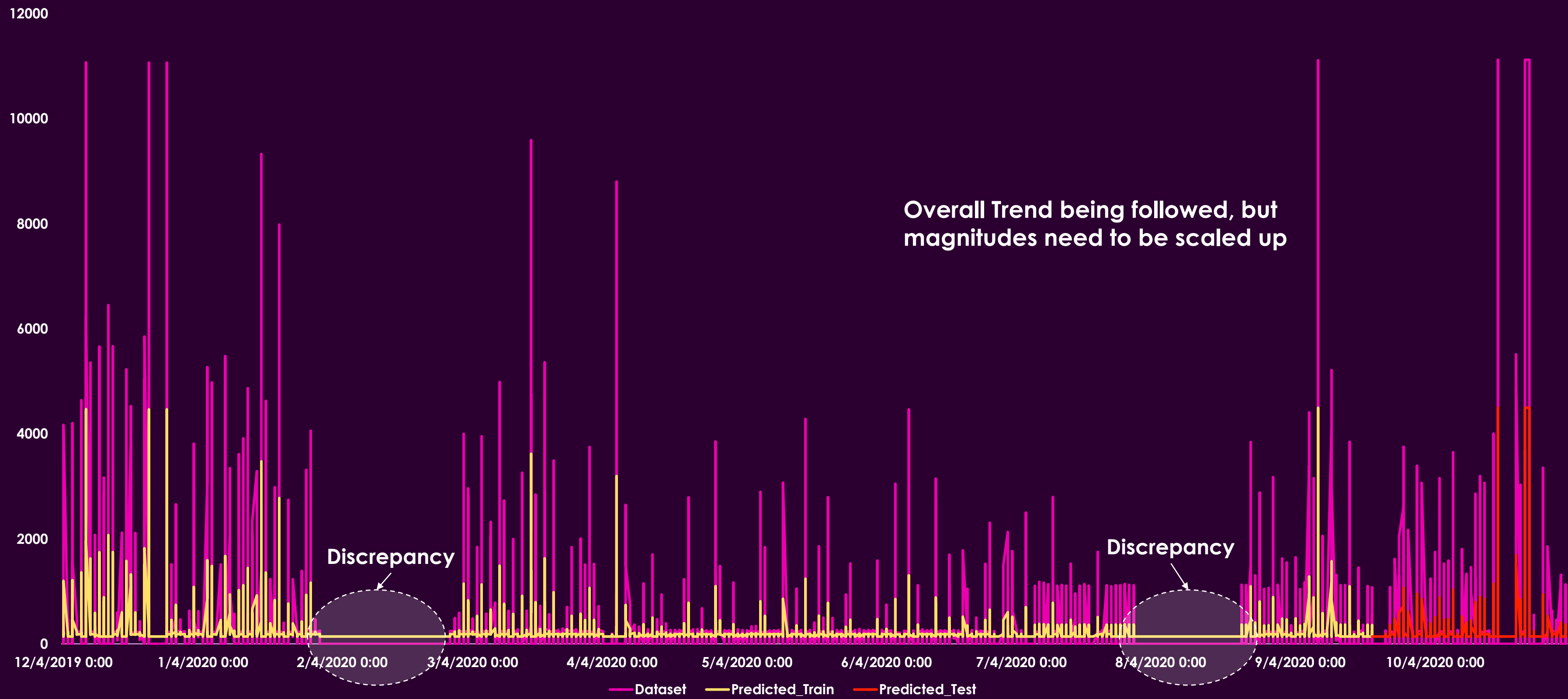
Y: Total EV consumption for next 4 hours

Model Name	Nodes	Layers	Batch Normalization	Optimizer	Loss	Epochs
Predicting 1 hour ahead	4	1	No	Adam	MSE	100
Predicting 4 hours of consumption using 1 day of past data	6	2	Yes	Adam	MSE	100

Model Name	Mean Square Error	Accuracy R2 Square
Predicting 1 hour ahead	Train Score: 585.17 RMSE Test Score: 819.82 RMSE	0.13
Predicting 4 hours of consumption using 1 day of past data	Train Score: 1414.49 RMSE Test Score: 5404.03 RMSE	0.15

Model Results – Trend being followed

Car ID EV0_325 Energy Consumption Prediction



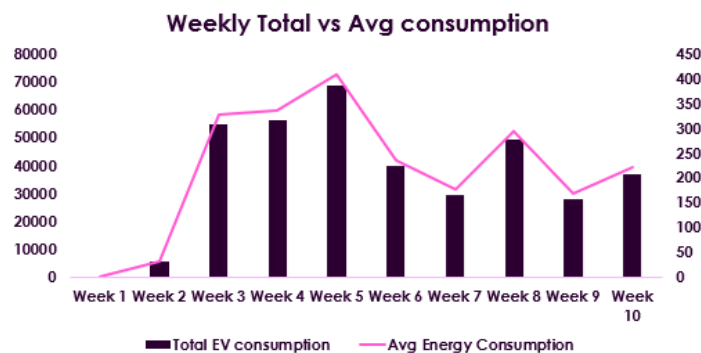
RECOMMENDATION & NEXT STEPS



NEW REPORTING UNDER ONE ROOF AND FULLY CUSTOMISABLE

Understand how your EV is consuming energy and how car needs to be charged to save electricity costs.

EV Weekly Overview



Highest Charging Hours



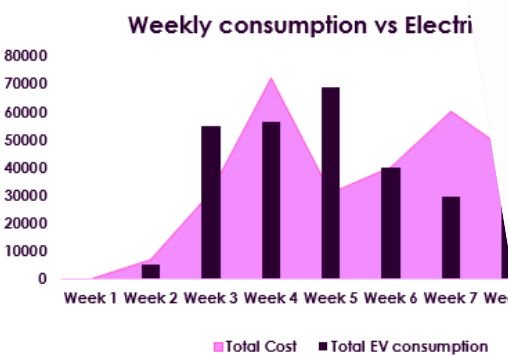
Highest Charging Days

Insight Report | Dec 2021

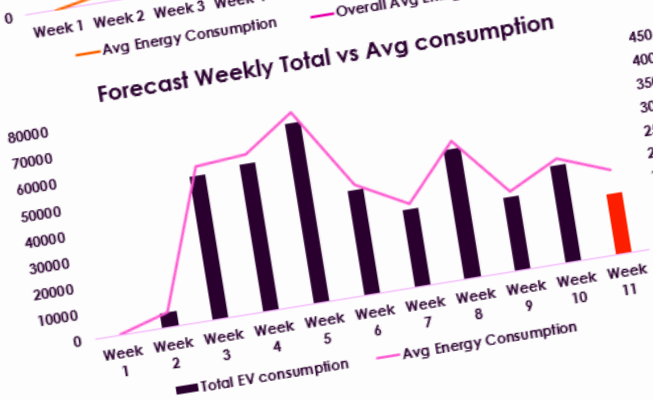
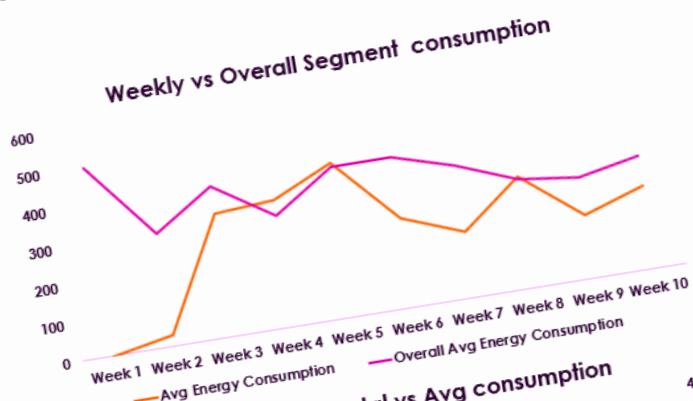
Monthly Energy consumption



2.5% drop

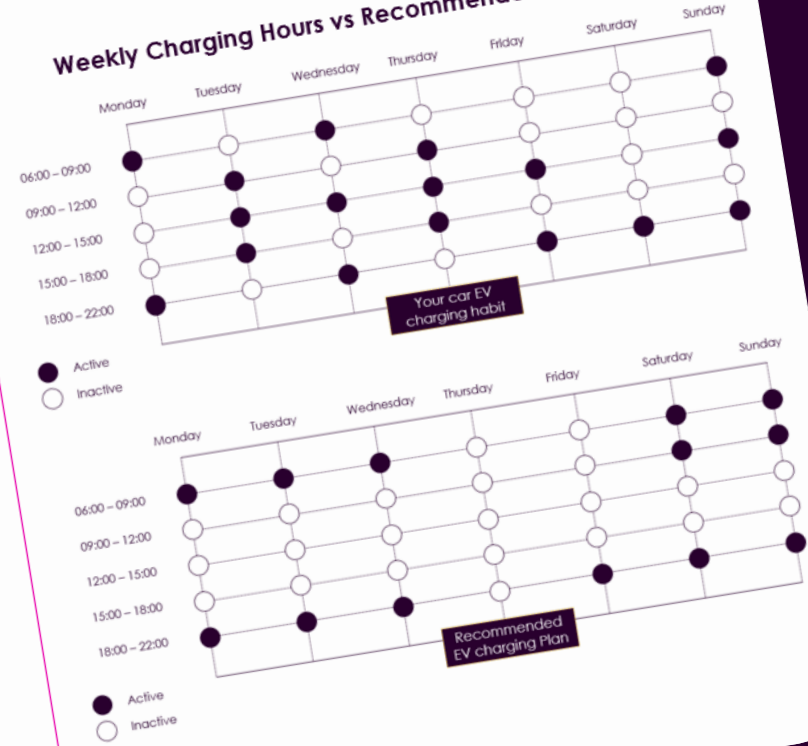


EV Weekly Overview



Insight Report | Dec 2021

Weekly Charging Hours vs Recommended Plan



Key Takeaways + Next Steps

1

New Dashboard Views

Metrics like last 7-day energy consumption for your car vs all cars in similar segment, Weekday vs Weekend consumption, most popular hours, days, anomalies and predicted future trends can be added into the dashboard.

2

Segment wise Model

Model with all segment wise cars needs to be created and evaluated to check accuracy

3

Finding the minimum data threshold

Crucial to determine how many data points are enough to start using LSTM model to predict future trends with high accuracy