Porsche EV Marketing Analytics

Customer Zipcode Attention Recommendation (CZAR)

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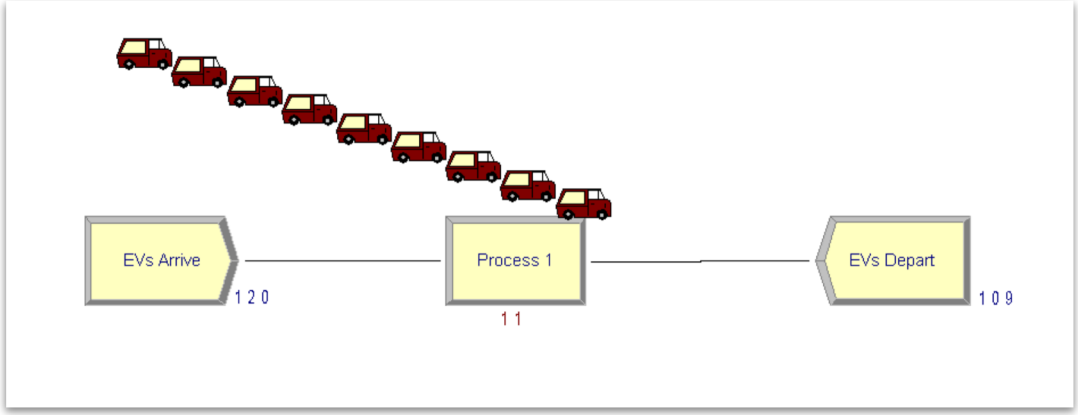
Phase 2 Submission

Model Benefits

- Marketing Recommendation model delivers business ready geographical drilldowns on optimized marketing targets segmented by consumer profile that can immediately be used in marketing strategy.
- A simulated wait time model provides a heat map of prioritized charging station locations based on consumer need as well as a weighted version to coincide marketing strategy for greatest ROI.
- Models allow for continuous improvement, allowing Porsche to improve its regional predictions over time.
  - Clusters are segmented along PCA orthogonal vectors to allow most robust segmentation.
  - Simulation can integrate Bayesian updating with new data.
  - Heatmaps can be trained and tuned in conjunction with new marketing data to ensure greatest ROI of marketing campaigns.
- The end-to-end model uses columnar data, machine learning models in python, and integrated live Tableau dashboard deliverables, so is easy to implement and can scale quickly based on data availability.

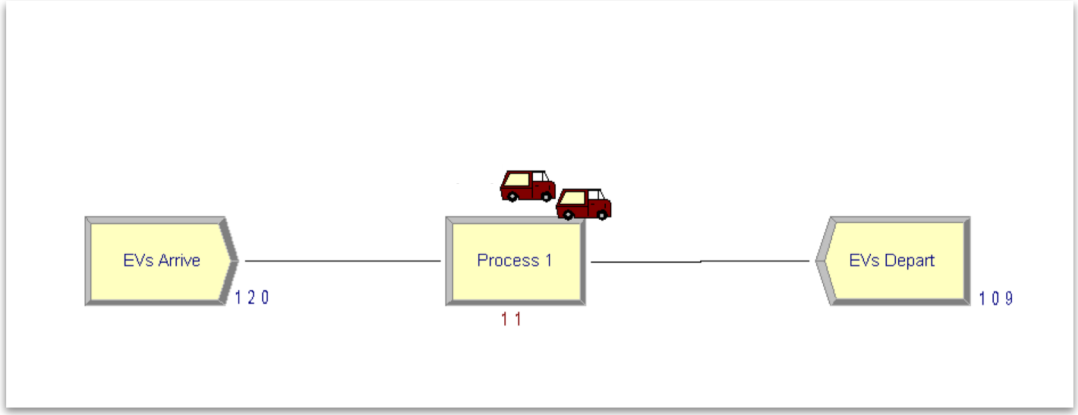
Q1 Optimized Charging Station Locations

Simulated Customer Wait Times



(Pre-Optimization) EV Charging Simulation

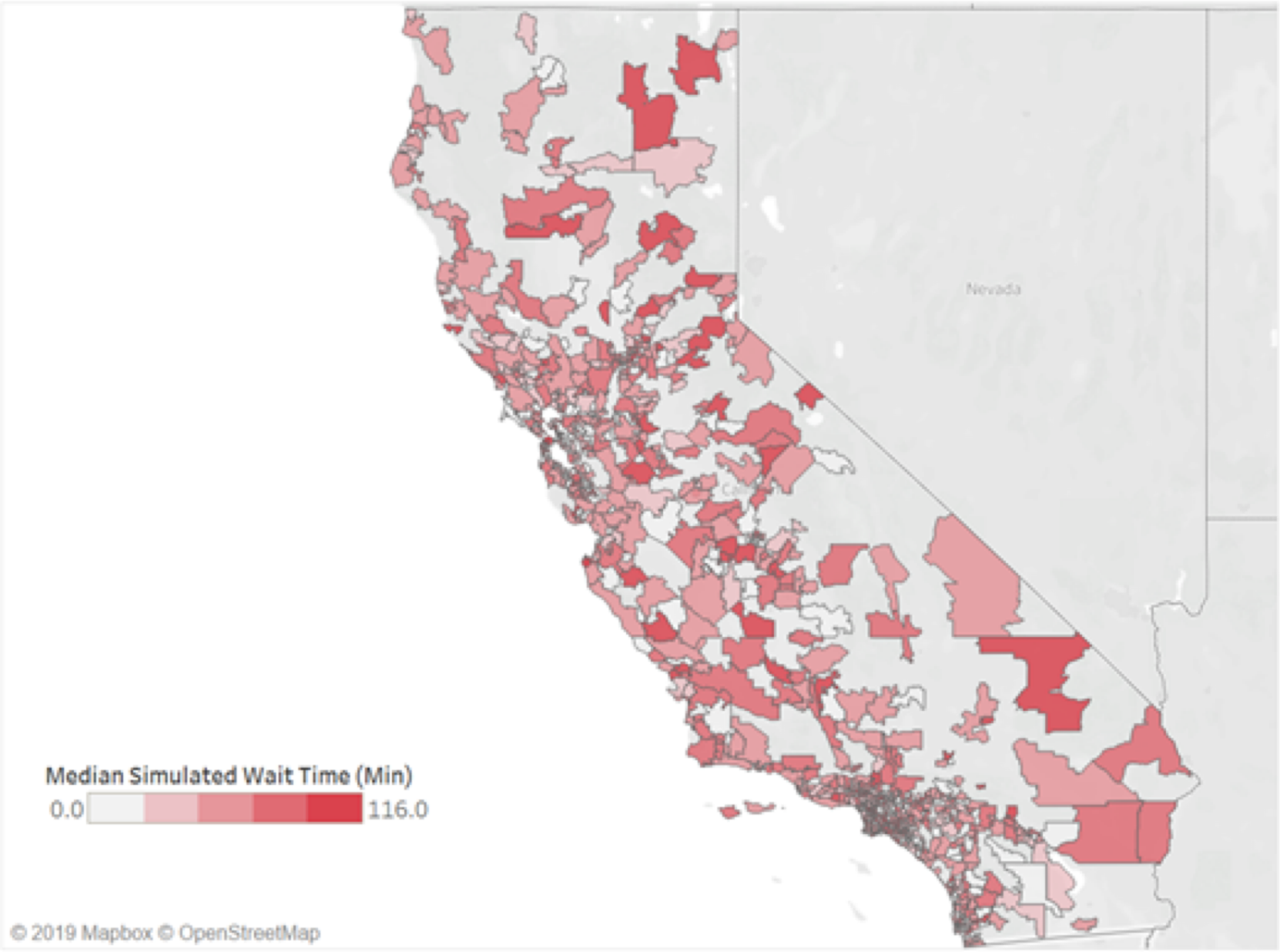
- Simulated wait times at charging locations over a five-hour period based on Chargepoint API data
- Ran simulations using SimPy and replicated in Arena to visualize long queue
- Created charging stations; EVs modeled with exponential interarrival times
- Wait times range from 0 to 122.215 minutes
- Simulation is easily scalable as more charger location data become available



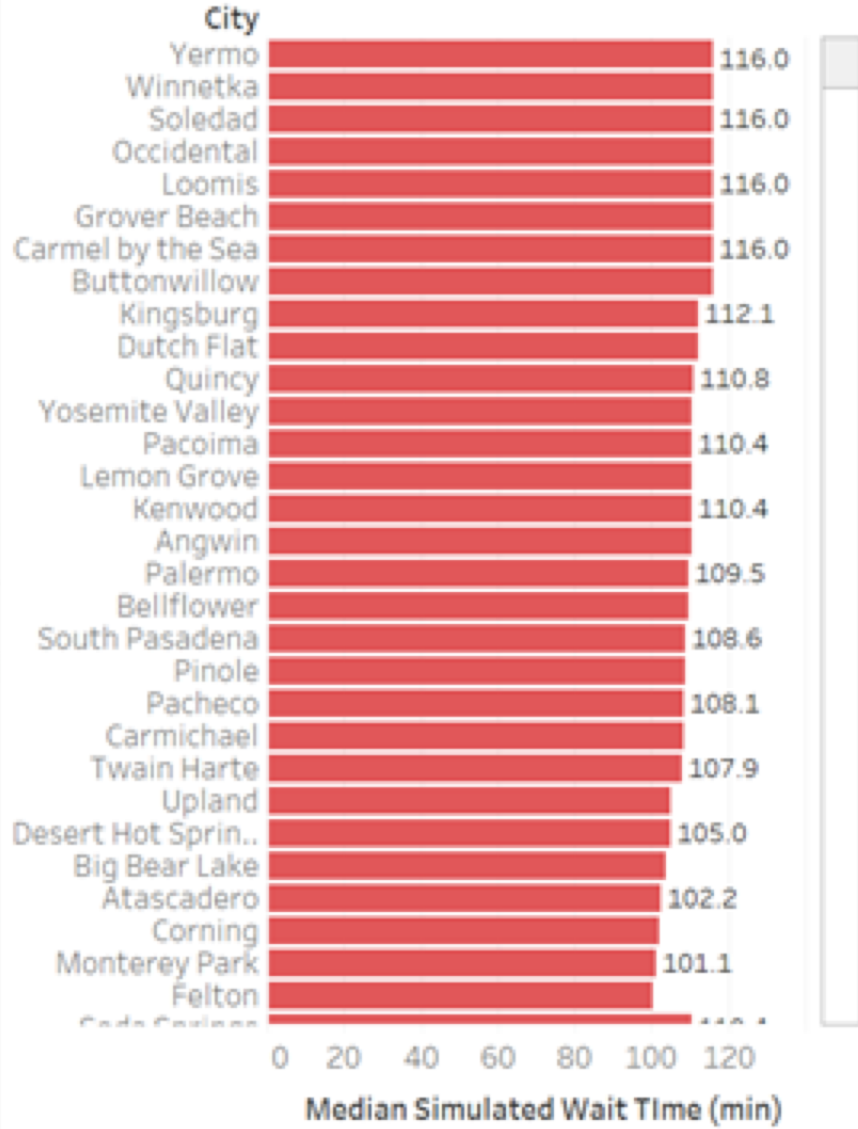
Optimized EV Charging Simulation

- Iterated on simulation model with varying feature inputs to reduce wait times
- Determined direct relationship between quantity of charging stations and wait times.
- Improved custom wait time by a factor of 4 in Arena simulation

Heatmap of Simulated Chargepoint Wait Times



Top Cities



Q1 Technical Explanation

Using Python and Arena, simulated wait times at EV charging locations (by zip code) using exponential interarrival of EVs and publicly available Chargepoint network data.

1. Normalize charging times across Levels 1-3 chargers to account for differences in charging rates and to find the equivalent number of total chargers (NUM_CHARGERS).
2. Set charge time as a random variable on the range of 30 to 120 minutes.
3. Set up and start the simulation.
    a. Create charging locations, initial EVs, and arranged for additional EVs with exponential interarrival times in minutes.
    b. EV arrives at the charging location and requests a charger.
    c. Begin the charging process (in parallel if NUM_CHARGERS > 0), waits for it to finish, and leaves the charging location.

Simulated wait times are used to provide suggested Chargepoint build numbers/zipcode on a heat map.

This technical solution is easily scalable as actual wait times and charger location data are made available and/or updated.

Q2 Customer Clustering Model and Segmentation into Marketing Personas

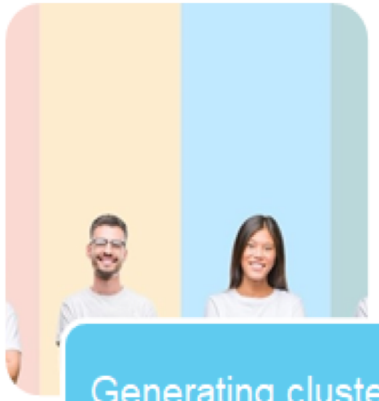
Q2 Technical Explanation

- Using principal component analysis, customers are clustered based on buying habits, demographics, and regional car proportions across fuel type including car cost and engine type. These clusters are identified as personas for targeted market strategies.

Zip code clustering using K-Mean

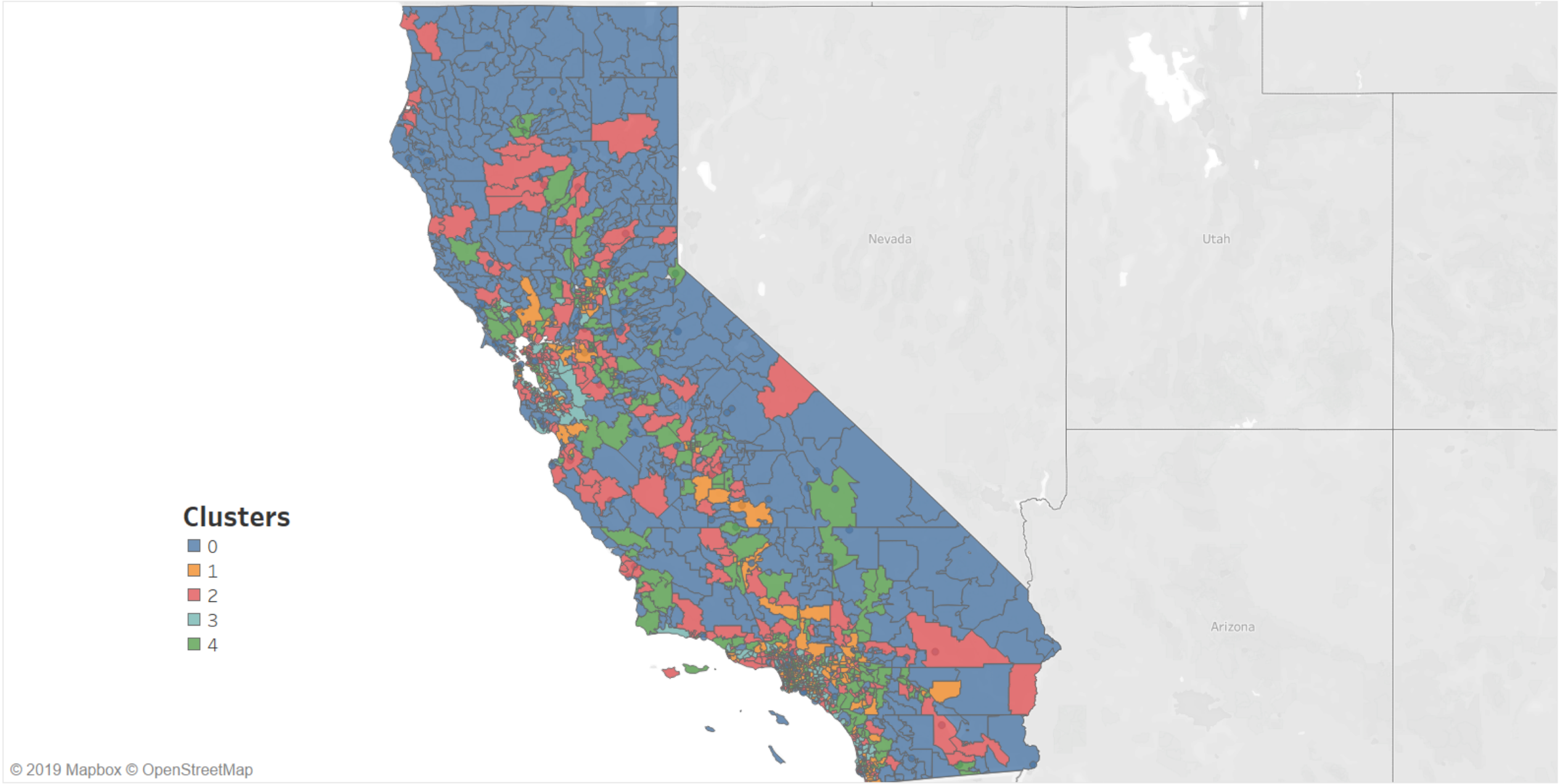
Computed cluster wise average feature values

Cluster ranked on features values



Generating cluster persona's using rank

Marketing Clusters by Zip Code



Customer Segmentation

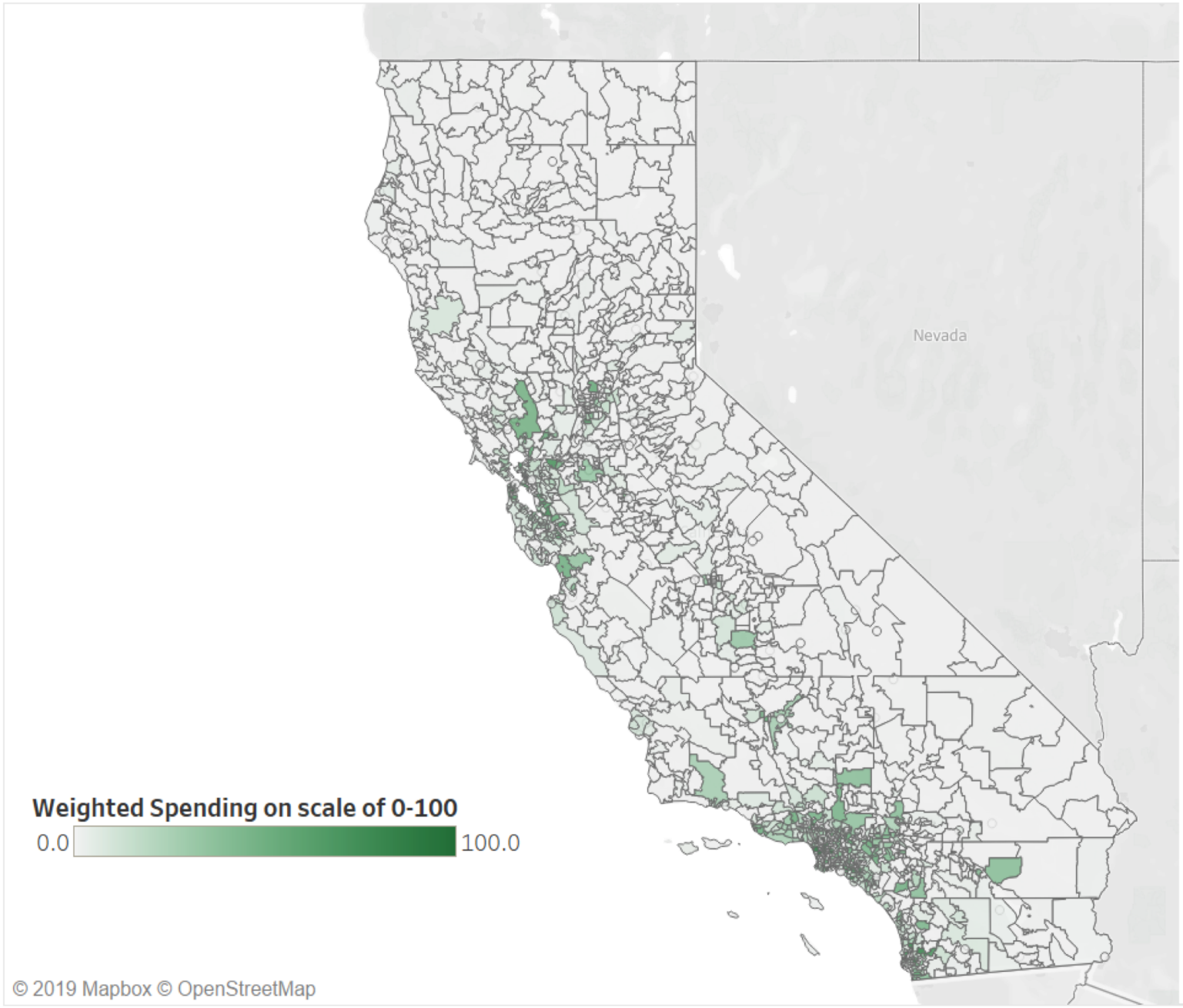




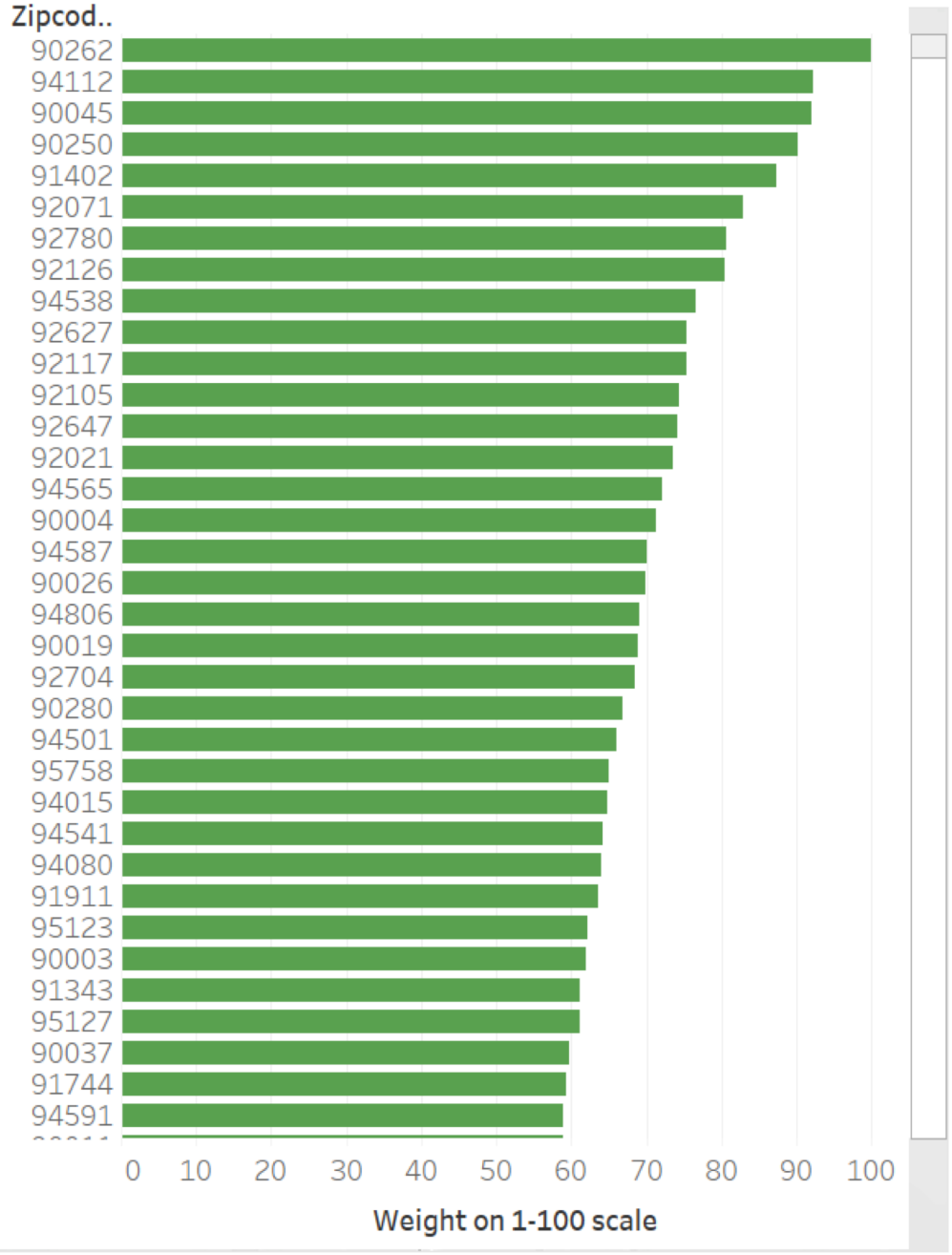
Customer Segments	Stalwarts	Risk Takers	Non Buyers	Upwardly Mobile	Pragmatists
Cluster	0	1	2	3	4
Gender	male	--	--	--	female
Highest Education Level	Associate Degree	High School	--	Master's Degree	Some college
EV Types within Cluster	Battery Electric Plug-in Hybrid	Battery Electric	none	Battery Electric Plug-in Hybrid	Battery Electric Plug-in Hybrid
Top Vehicle Price	$40k	$100k	$30k	$100k	$30k
Income	$0 - $49k	$ 50k - $99k	--	$100k+	--
Occupation	construction maintenance	sales transportation	--	arts	service
Housing	homeowner	homeowner; owns 3 vehicles	--	mix of homeowners & tenants; owns 1-2 vehicles	mix of homeowners & tenants
Home Value/ Rent	$50k - $150k	--	--	$500k - $1M/ $1500+	$150k - $500k/ $500 - $1500

Q3 Marketing Recommendations: Recommended dollar spend per zipcode provided based on user-inputted EV type and cost

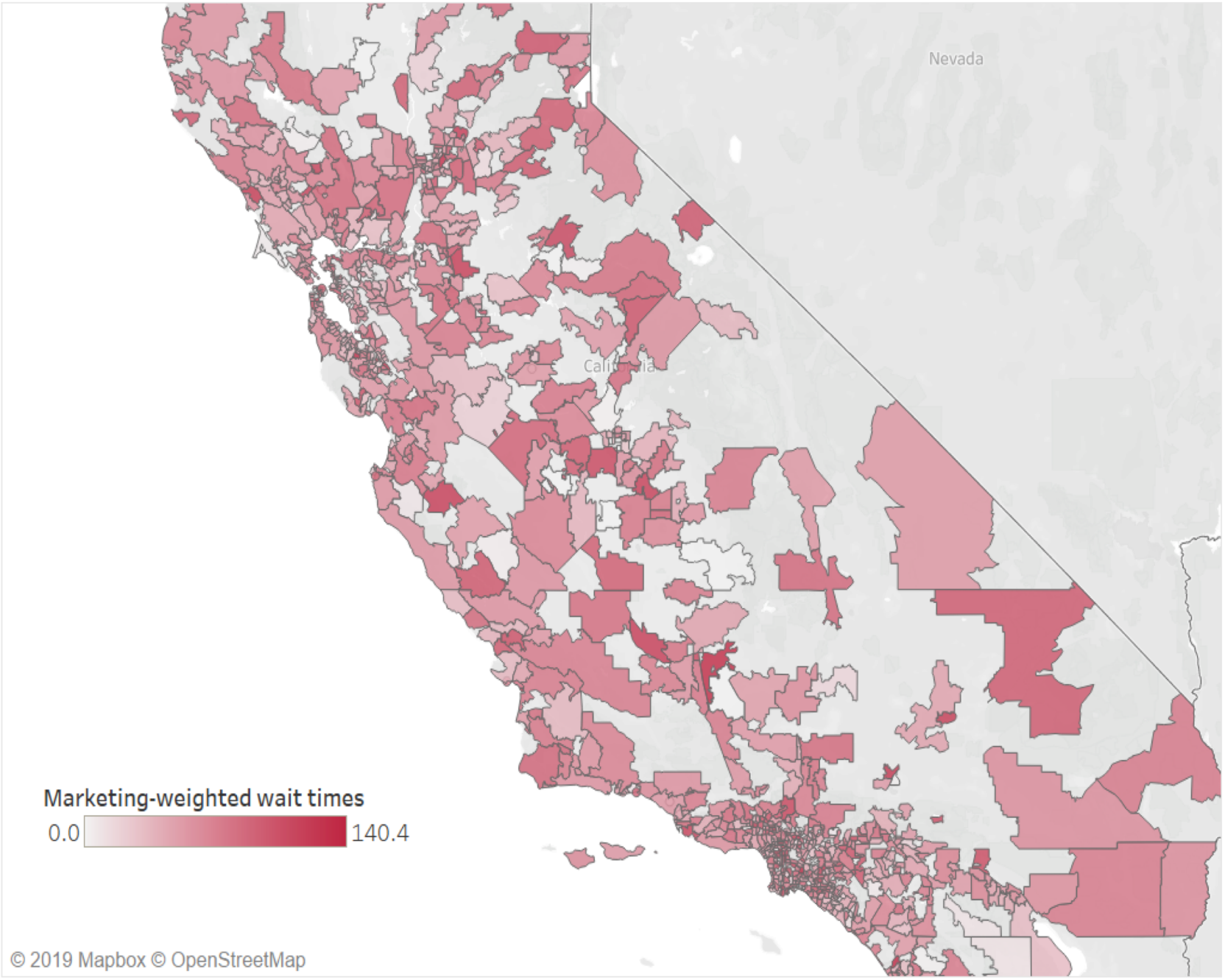
Targeted Marketing Dollar Spend by Zipcode



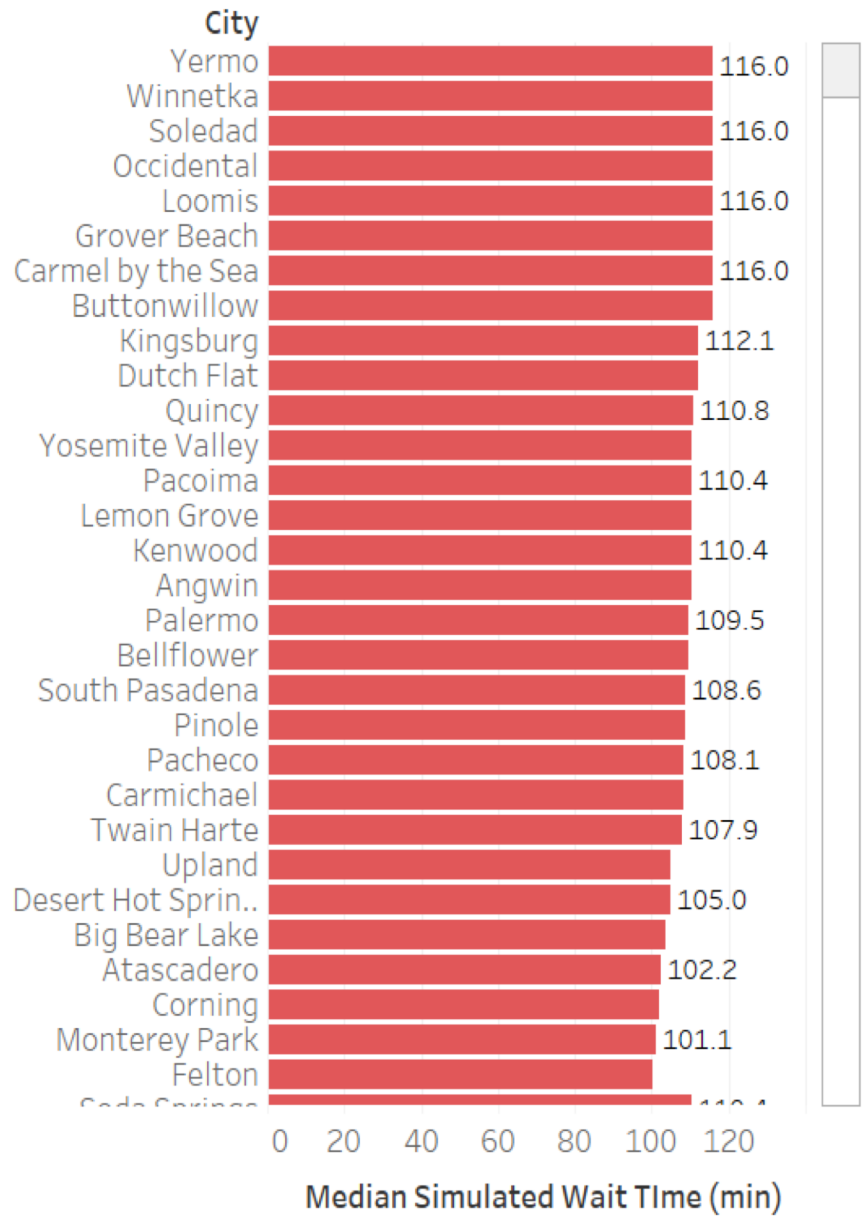
Top Zipcodes by Weighted Spend



Marketing Heatmap of Chargepoint Build Locations



Top Cities



Q3 Technical Explanation

- Taking an inputted Porsche car profile, a weighted marketing dollars suggestion towards each cluster is provided on a live heatmap.
- Weighting is based on cluster output and proportion of each car type and price range owned out of total cars owned in each zipcode, a per-cluster weighting of inputted.
- Weights can be varied via linear regression of coefficient of different demographic values and how they influence likelihood to purchase targeted vehicle.

Future Steps

- Deliver Model to Production system and Workbooks to business users, end-to-end POC is provided.
  1. Ingest data into cloud or on-prem server.
  2. Run python script in Databricks to deliver clustering results to tables on the cloud server.
  3. Use a live connection of the data to Tableau.
  4. Business stakeholders can use live Tableau workbooks to plan marketing decisions
- Continuously iterate, tune, and improve model.
- Collect data from marketing campaigns, use A/B testing to refine marketing model and materials.

Future Model Iterations

- Collect and ingest data on effect of marketing on $ lift in revenue from the targeted zip code, using A/B testing where possible against a control variable. Integrate this data to fine tune clustering model and continuously improve regional marketing strategy.
- Update simulation model of wait times with distribution of new recorded wait time data.
- Reweight Q1 chargepoint heat map with marketing recommendations found in Q3, using a Bayesian computation of the updated function formed by Q1 and Q3 distributions via Monte Carlo approximation of the posterior distribution

Data sources

https://factfinder.census.gov/faces/nav/jsf/pages/searchresults.xhtml?refresh=t&keepList=t (DEMOGRAPHY DATA)

https://afdc.energy.gov/data/?q=electricity (PUBLIC EV CHARGER DATA)

https://www.dmv.ca.gov/portal/dmv/detail/pubs/media_center/statistics (VEHICLE STATS)

- Selected 5-digit tabulation areas within California
- Selected dataset for desired topics from the topics tab

Thank you!

Additional Materials (not to be presented)

ATLytiCS Data for Hope: Assessing Environmental Impact ASSESSMENT RUBRIC

Assessment Dimension	Priority	Score
Answers community question	High	
Follows data science best practices	High	
Innovative approach	Medium	
Presented in a consumable manner	Medium	
Capable of implementation	Low	
Solution is scalable	Low	

Judges reserve the right to apply this framework for their assessment, and may deviate if they feel necessary

ATLytiCS
Atlanta Analytics for Community Service

Recall the Three Community Questions

1. Where to build which charging stations and why?
2. What customers are likely to buy which EVs, which ones aren’t?
3. Who should we market to, what kind of cars, and where?

1. Where to build which charging stations and why?

What we will deliver:

Prioritized ranking by Return on Investment (ROI) of each charging station type with product components, type of location it would be installed (e.g., corporate offices, hotels, stores, gas stations), and in which zip code.

Example deliverable

Charging Type	Location Type	White Glove/ Elite Service	Zip Code	Quantity	Charging Time	Connectors	ROI
Level 2	Supermarket	Yes	30316	5	2 - 8 hrs	SAE J1772	40-50 customers per day
Level 2	Mall	Yes	30324	15-20	2 - 8 hrs	SAE J1772	500-1000 customers per day
Level 2	Amusement parks	Yes	30349	15-20	2 - 8 hrs	SAE J1772	500-1000 customers per day
Level 3	Government Office and Buildings	No	30301	4-5	0.5-1 hr	CCS connector	100-150 customers per day

1. How we will deliver charging station recommendations:

Using the following data:

Quantitative

- Last used (by car type)
- Hours of operation
- Population
- Proximity to major city, shopping, work, industrial area
- EV car # to charger # proportion per zip code
- Chargepoint API

Qualitative

- Geographical location of existing EV charging stations
- EV charging types:
- Level 1
- Level 2
- Level 3/DC Fast Chargers
- Customer feedback on charger types and preferences

We will use the following modeling approach:

Using current data on number of EV owners per zip code compared to locations of publicly available charging stations in conjunction with chargepoint data on waiting lines, we will simulate charging station placement to minimize wait lines for EV users in high traffic areas.

Simulation results will be used in conjunction with Q2 location clusters for zipcodes most likely to purchase target Porsche models to create a linear optimization model to increase availability in target regions while taking into account cost constraints.

Charging preferences by consumers will be regressed against specific location types to add additional weights to the optimization model and specify types of locations/buildings within a zip code to target.

2. How we will deliver customer segments:

Using the following demographic data:

Quantitative

- Demographics of Electric vehicles consumer of each state by Age, income(dual-income), gender, location, profession, industry, degree
- Type of vehicle like SUV, Sedan or Hatchback and its price, Type of Home.
- Same Demographics above of Consumers having gasoline cars above $100k to understand the buying trends and factors.

Qualitative

- Each state's regulation policies and laws (Tax-Rebates).
- Social media analysis of Reviews of EV to understand behavioral trends.

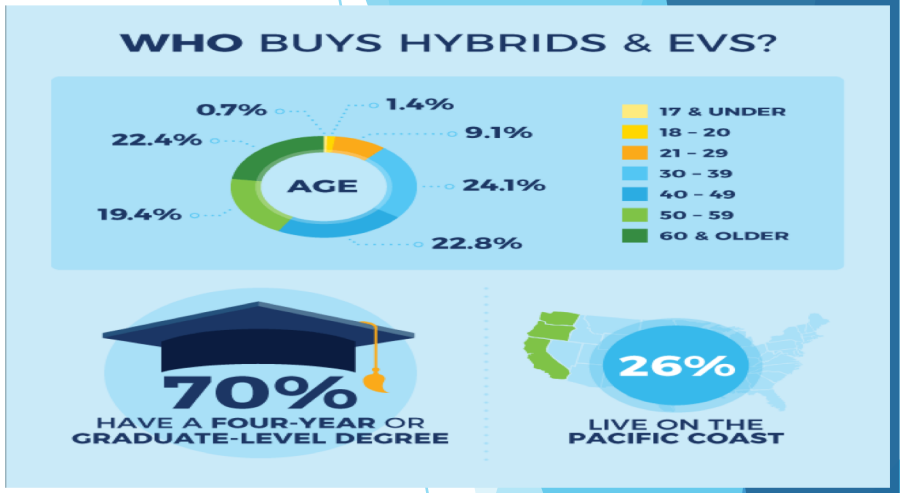
We will use the following modeling approach:

Segmenting customers using K-means, we can build a classifier model in each segment to determine the probability of a customer buying the vehicle or not.

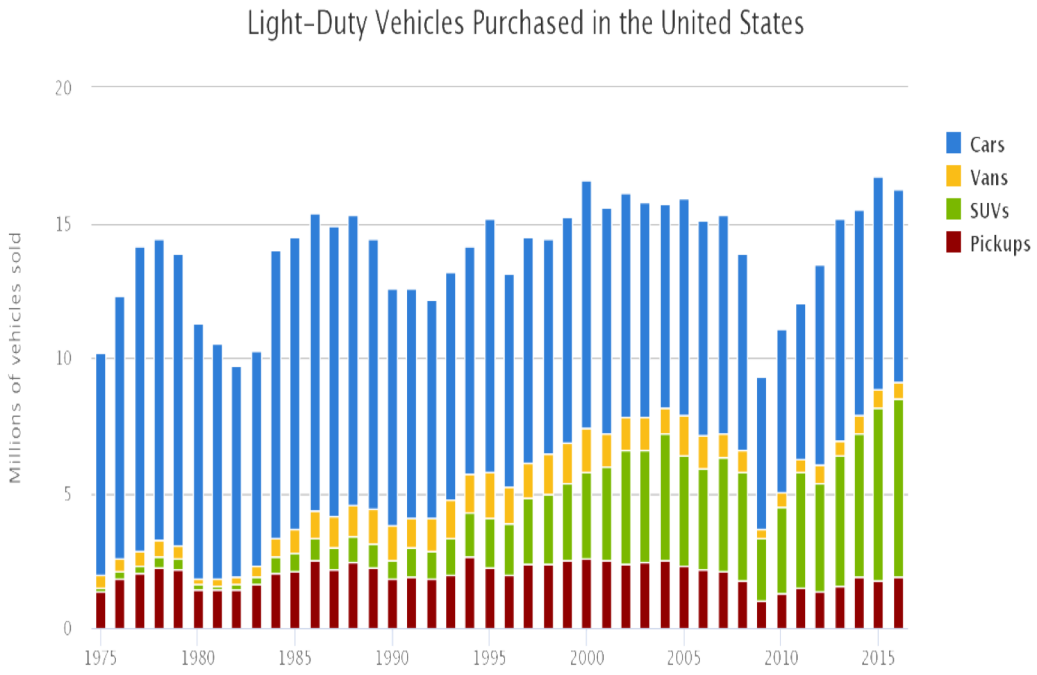
3. What kind of cars should be marketed to who and where?

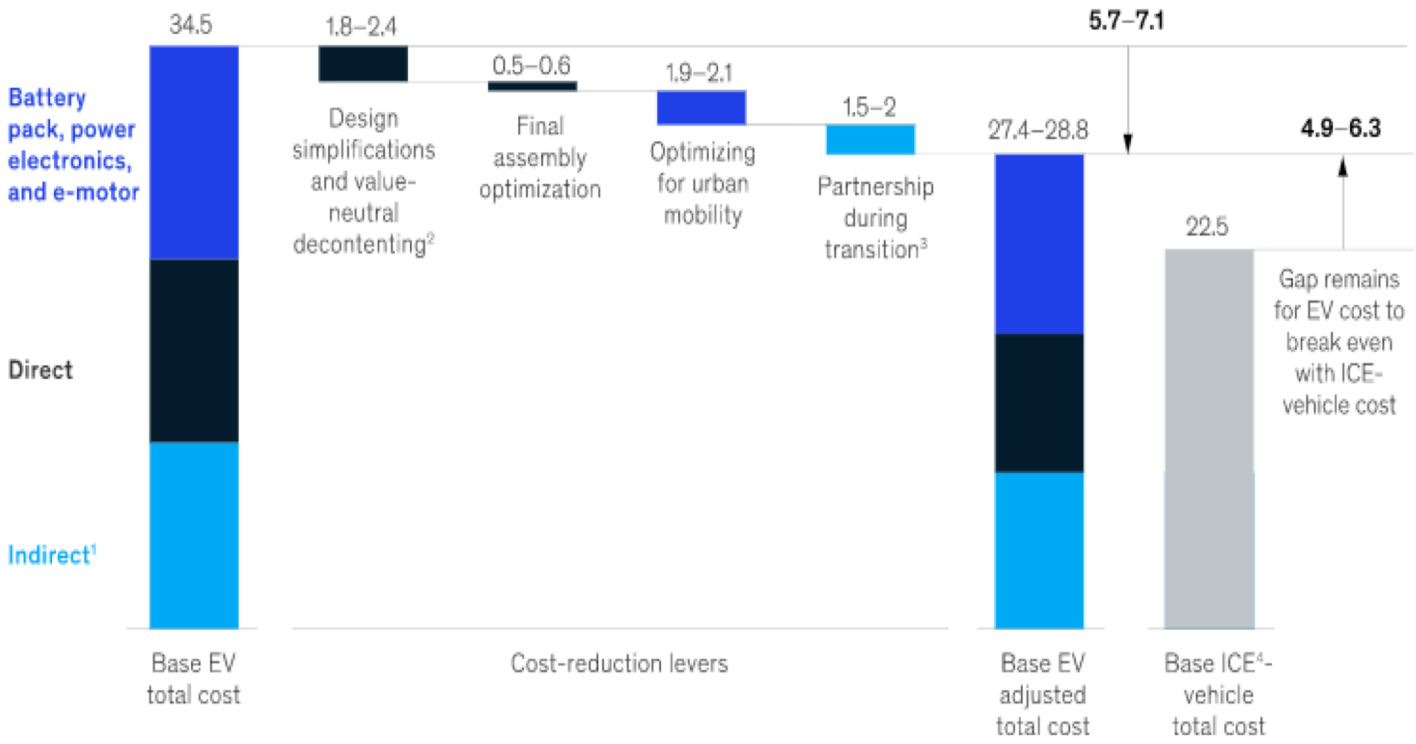
What we will deliver:

Per car, which persona it should be marketed to in which manner to which region, ranked by probability of opportunity and number of expected sales.



Visualization of marketing guidance:





3. How we will suggest marketing recommendations:

Using the following data:

Quantitative

- Demography of each state by Age, income(dual-income), gender, location(zip-code,rural,urban) , profession, industry, degree(very important)...
- Type of vehicle like gasoline, hybrid and which kind of vehicle like suv, sedan
- Price of vehicle
- Persona clusters and data defined in response to question 2.
- Marketing campaign data w/ sales trends

Qualitative

- Each state's regulation policies and laws
- Persona clusters and data defined in response to question

We will use the following modeling approach:

Using decision tree algorithms based on EV features, we will be able to pair any EV build and cost to our persona clusters, and provide a breakdown of marketing dollar spend for each customer group and location based on probability of purchase.

3. What kind of cars should be marketed to who and where?

Example deliverable

Customer Segment	Vehicle Type & Ranked Probability	Marketing & Advertising	% Marketing Budget	Region	Expected Sales
Pragmatists	BMW i3 (44%) Nissan LEAF (27%) Tesla Model 3 (16%)	Online ads including banner ads and social media	Online Ads: 100%	Southeast	$200M
Risk Takers	Tesla Model S (52%) Tesla Model X (41%) Jaguar I-PACE (9%)	Online and Print Ads	Online Ads: 50% Print Ads: 50%	West Northeast	$178M
Upwardly Mobile	Tesla Model S (62%) Jaguar I-PACE (6%)	Online and Print Ads	Online Ads: 35% Print Ads: 65%	Mideast Southeast	$105M
Near-Retirees	Tesla Model X (60%) Tesla Model S Long Range (32%)	Print ads including direct mail, flyers, and ads in magazines and newspapers	Print Ads: 100%	Southeast Midwest	$50M

General Marketing Ideas and Suggestions

- Charging Infrastructure
  - Invest in chargers in public spaces
  - Disseminate information on charger locations

- Consumer Awareness
  - Establish public demonstration of PEVs
  - Develop a consumer education plan

- Cost Reduction
  - Alleviate battery ownership risk
  - Optimizing EV designs – Decontenting, design revision
  - Collaborating with competitors to reduce R&D, tooling and plants cost.
  - New Business Models – Battery Leasing and fleet sales

Optimal Strategy

- Favorable Geography
  - Provide tax incentives for purchase
  - Invest in chargers in public spaces
- Preferred type
  - Cars, SUVs occupy major chunk in Light-Duty Vehicles
- Customer Targeting
  - Advanced degree holders
  - Household income > $100,000
  - Access to free charging(Workplace/Public)
  - Solar PV adoption among PEV owners

Data Sources

- Scrape Chargepoint site or use Chargepoint API
  - https://volttron.readthedocs.io/en/develop/specifications/chargepoint_driver.html
- Alternative Fuel Stations
  - https://developer.nrel.gov/docs/transportation/alt-fuel-stations-v1/
- Porsche Taycan Models (Literature Review)
  - https://www.porsche.com/usa/models/taycan/taycan-models/taycan-turbo/
- Charging Up the Porsche Taycan: Fast Charging and More (Literature Review)
  - https://www.chargepoint.com/blog/charging-porsche-taycan-fast-charging-and-more/

Data Type

- 1) VEHICLE REGISTRATION of new york

Record Type	VIN	Registration Class	City	State	Zip	County	Model Year	Make	Body Type	Fuel Type	Unladen Weight	Maximum Gross Weight	Passengers	Reg Valid Date	Reg Expiration Date	Color	Scoffla w Indicator	Suspension Indicator	Revocation Indicator

- 2) vehicle registration of california -

Registration Class	ZIP	Model Year	Fuel	Make	Duty	Vehicles

- 3) vehicle counts of illinois
- 4)scrapped user reviews of electric vehicle and find out the difficulties they are facing and analyze their sentiments by natural language processing.

Business Deliverables

1. Where to build which charging stations and why?
2. What customers are likely to buy which EVs, which ones aren’t?
3. Who should we market to, what kind of cars, and where?

Iteration I

- Porsche EV Strategy Iteration 1:
  Q1. Simulated waiting times and proportion regional charging point to EV users are minimized in a linear optimization model to provide suggested chargepoint numbers/zipcode on a heat map.
- Q2: Using principal component analysis, customers are clustered based on buying habits, demographics, and regional car proportions across fuel type. These clusters are identified for targeted market strategies.
- Q3: For a Porsche car profile, a weighted marketing dollars suggestion towards each cluster is given on a live heatmap.
- Future steps: Improve simulation to Bayesian simulation combining prior of exponential function and a Monte Carlo simulation based on existing data to get more accurate wait times.

  Weight chargepoint locations by marketing strategy.