Surrey Electric Vehicle Project:
Data Analysis and Visualization for Surrey’s Electric Vehicle (EV) Transformation Strategy

Laura Greenstreet, Eugenie Lai, and Alexi Rodriguez-Arelis
Intro to Surrey & Project Background

- Surrey is the 2nd largest city in Metro Van with a population of ~550,000
- Surrey grew 10.3% from 2011-2016
  - 6.5% growth across Metro Van
- Expected to have over 800,000 residents by 2050

The city’s decisions now will have a big impact on regional sustainability

* Based on City of Surrey figures
Intro to Surrey & Project Background

- Surrey wants to grow sustainability
  - Developing rapid transit corridors
  - Developing a zero waste strategy
  - Limiting greenhouse gas (GHG) emissions per capita to 2007 levels
- **Transit** is Surrey’s largest source of GHGs
- Surrey’s Electric Vehicle (EV) Strategy with the goal of transitioning the whole vehicle stock to zero-emission vehicles by 2050
Why do EVs need a strategy?

- Electric vehicles adoption faces a chicken-and-egg problem
- City funds early development and the private sector takes over in the long term
- Other challenges include:
  - Range anxiety/public perception
  - High entry price
  - Limited styles of car available
Current State of EV Adoption in Surrey

- Current Adoption: < 1% of total vehicles
- 2018: 100% of vehicles in market
- 2050 Goal: 70 Charging Sites
Our Role: Provide insights to guide the EV strategy development

**Infrastructure**
Where could the city strategically put future charging sites?

**EVs**
How many EVs are in Surrey and where are they located?

**Consumers**
Who/where are the current/potential EV consumers?
Our Approach

- Create a database to capture the structure of the data
- Create an app to interactively visualize the data
- Connect the app and database so new data can be easily visualized
App Demo
Next Steps: Analyze the Data

Where are current EV owners and who will buy an EV next?

Where should additional charging stations be built?
Literature Review: Classifying Potential EV Buyers

- The three categories of EV buyers:
  - Categories were defined based on:
    - vehicle ownership
    - land use
    - demographic information and sentiment analysis

Classifying EV Buyers: Demographic Differences

<table>
<thead>
<tr>
<th></th>
<th>Pioneers</th>
<th>Early Mainstream</th>
<th>Late Mainstream</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Income</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Housing</td>
<td>Mostly owned</td>
<td>Mixed</td>
<td>Mostly rented</td>
</tr>
</tbody>
</table>

- Pioneers: Mostly owned
- Early Mainstream: Mixed
- Late Mainstream: Mostly rented
Statistical Modelling

1. Regression Models:
   a. Response: Electric vehicles
   b. Covariates:
      i. Special vehicle classes
      ii. Demographics

2. Hierarchical clustering
   a. Dendrograms
   b. Outlyingness factors

Continuous

Poisson
Quasi-Poisson
Negative Binomial
Motivation for Regression Count Models

1. A count approach targets those areas with large EV stocks
2. Interesting regression alternatives
3. Better data fits
4. Clustering coming from count variables aligns profiles to existing literature

Demographic factors coming from literature

- +$100K
- Detached houses
- Bachelor's
- Owners
- 4+ persons
- 35 to 64 years old

5 clusters instead of 3

Special vehicles (Hybrid and Luxury) and demographics as counts
Clustering by Counts

Literature Factors

Special Vehicle Classes

Total Stock

Key Demographics

Household Income ($100K+)

Housing Type (Detached)

Education (Bachelor's+)
Motivation for Proportion Model

1. Counts are correlated with population
2. Demographic features should work regardless of population size
3. **Question to answer:** What makes an area have **high EV proportion?**
Cluster by EV Proportion

Literature Factors

- Income: 100K+
- Housing Type: Single Family or Semi-Detached
- Education: Bachelor’s and Above
- Age: 35-64
- House Ownership: Owner
- Household Size: 4+ people
Cluster by EV Proportion

Interesting Factors not Covered in Literature
Feeding Back to Feature Selection:
Interesting Factors not Covered in Literature

Assigning EV Proportion
Correct Classification: 89%
Feeding Back to Feature Selection:
Interesting Factors not Covered in Literature

Assigning EV Count
Correct Classification: 89%
Takeaway: Two Different Lenses for Two Different Uses

- **Count model:**
  - Highlights areas with high population and decent EV adoption
  - These areas can be targeted to increase total EV sales

- **Proportion model:**
  - Suggest areas *overseen* by the count model
  - Good for targeting areas with less population but *higher* chances to adopt EV
NRCan Charging Site Proposal

- This fall, Surrey will be submitting a curbside charging site proposal to Natural Resources Canada
- Where should the chargers go?
What makes a good place for a charger?

- Where do people charge?
  - At home
  - At work
  - During activities like shopping, dining, or recreation
- The grant covers curbside chargers, so we’ll focus on chargers away from homes
What makes a good place for a charger?

- **Important factors for chargers targeting employees:**
  - business count
  - traffic flow to areas in the AM

- **Important factors for chargers targeting shoppers/diners:**
  - retail locations
  - traffic flow to areas during the midday
Destination Score Model

- Identify retail/business areas that could access a single charger
- Score each area based on the amount of traffic to the area
- Place chargers at sites with the best scores
Retail Results -

1. Central Shopping Centre
2. Cedar Hills Shopping Centre
3. 72nd and King George Blvd.
4. Morgan Crossing
5. Morgan Crossing
Retail Results -

1. Central City Shopping Centre
2. Cedar Hills Shopping Centre
3. 72nd and King George Blvd.
4. Morgan Crossing
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Uneven Access: Placing 3 Chargers
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Uneven Access: Placing 3 Chargers
Improved Access Model

- Weight traffic by the proportion of traffic from an origin that can reach a charger
- Add charging stations one at a time based on which adds the most utility
- **Backtrack** when the utility of a charger in the chosen set is less than the utility of one in the available set
- Repeat until you’ve placed all of the chargers
Retail Results -

IN PROGRESS
Future Work

- Consumer classification on a wider range of features
- Developing a better understanding of charging capacity and utilization
- App maintenance and feature development as EV Strategy progresses
End of Presentation

Thank you for your attention

We are now open to questions
## Vehicle Counts by Year - Table

<table>
<thead>
<tr>
<th>Year</th>
<th>Hybrids</th>
<th>EVs</th>
<th>Personal Vehicles</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>206</td>
<td>0</td>
<td>190,538</td>
</tr>
<tr>
<td>2011</td>
<td>1,750</td>
<td>1</td>
<td>221,068</td>
</tr>
<tr>
<td>2016</td>
<td>4,350</td>
<td>313</td>
<td>266,750</td>
</tr>
<tr>
<td>2017</td>
<td>5,072</td>
<td>717</td>
<td>277,687</td>
</tr>
<tr>
<td>2018</td>
<td>5,941</td>
<td>1,226</td>
<td>286,987</td>
</tr>
</tbody>
</table>
Let $C_i$ be a destination cluster, $T$ be the set of all TAZs, $T_i$ be the set of TAZs $C_i$ has properties in, and $F(A,B)$ be a function of traffic flow from $A$ to $B$.

\[
\text{Score for } C_i = \sum_{j \in T_i} \left[ \frac{\text{# properties in } TAZ_j \text{ and } C_i}{\text{# properties in } TAZ_j} \right] \times \sum_{k \in T} F(TAZ_k, TAZ_j)
\]

- Can be interpreted as the sum over all TAZs $C_i$ has property in where each TAZ contributes a value equal to total traffic flow into the TAZ times the proportion of traffic to the TAZ destined for a property in $C_i$.
- Uses traffic flow to an area as a proxy for the need for potential charger usage.
- Assumes people travel approximately equally to all businesses in a TAZ and that all traffic to a TAZ is for work/shopping.
- Can use employee count instead of property count to skew higher amounts of traffic to larger businesses.