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 sustainably by:
  - Developing rapid transit corridors
  - Developing a zero waste strategy
  - Reduce greenhouse gas (GHG) emissions
- **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

* Based on 2007 Community Energy & Emissions Plan
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

- < 1% of total vehicles
- 100% of vehicles in market

- 2018
- 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?

**Motivating Questions**

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

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

Design a Data Structure → Process the Data → Build a Database → Create a Visualization Tool
Next Steps: Analyze the Data

- Where are current and potential EV buyers?
- Where are the best locations for new charging infrastructure?
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

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<thead>
<tr>
<th></th>
<th>Pioneers</th>
<th>Early Mainstream</th>
<th>Late Mainstream</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>Mostly owned</td>
<td>Mixed</td>
<td>Mostly rented</td>
</tr>
<tr>
<td>Income</td>
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<tr>
<td>Education</td>
<td></td>
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<tr>
<td>Housing</td>
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</tbody>
</table>
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
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 or higher
- Owners
- 4+ persons
- 35 to 64 years old

5 clusters instead of 3

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

Special Vehicle Classes

Literature Factors

Key Demographics
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

- Luxury Proportion > 0.138
- Commutes Starting from 5-7.59AM < 0.258

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

Luxury Count > 663

1. People that Work from Home > 679

Assigning EV Count
Correct Classification: 89%
Count or Proportion: Two Lenses for Two 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?

- 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. Guildford Town Centre
2. Central Shopping Centre
3. Cedar Hills Shopping Centre
4. Morgan Crossing
5. Morgan Crossing
6. 72nd and King George Blvd.
Retail Results -

1. Guildford Town Centre
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Retail Results -

1. Guildford Town Centre
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6. 72nd and King George Blvd.
Uneven Access: Placing 3 Chargers

Diagram showing the placement of 3 chargers and their distances from 4 locations.
Uneven Access: Placing 3 Chargers
Updated Results -

- First 19 sites same as the first method
- Occurs because each origin only travels to a few destinations
- Emphasizes importance of distributing sites across Surrey
Updated Results with Existing Chargers -

- Only 12 existing retail clusters contain an existing charging site (green)
- 3 of these clusters are in the top 6 locations ranked by our algorithm (red)
Using scores to choose $n$
Future Work

- **Consumer Classification**: Run on a wider range of features
- **Charging Site Placement**: Develop a better understanding of charging site capacity and utilization
- **App**: Add new datasets as they become available update features as EV strategy progresses
End of Presentation

Thank you for your attention

We are now open to questions