PLUGGING IN AND CHARGING UP

Increasing Plug-in Electric Vehicle Adoption by Residents of Multifamily Buildings in Los Angeles County

Ben Chou

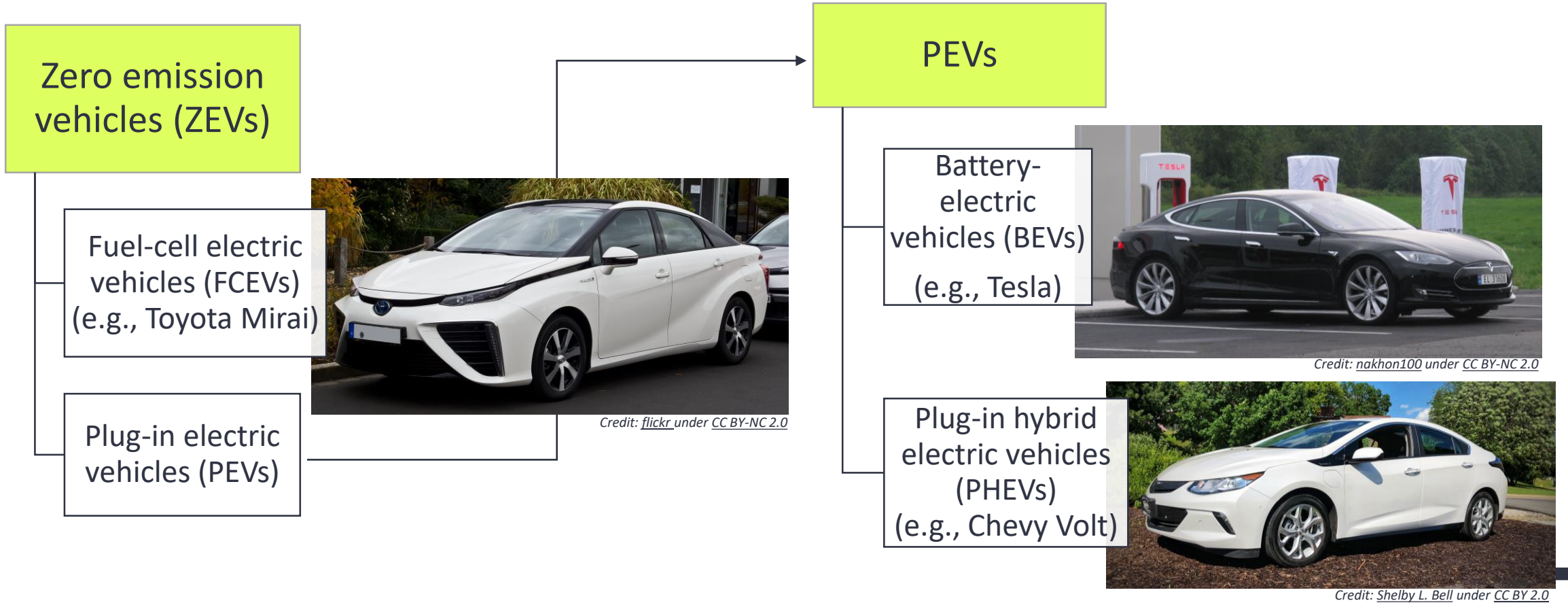**Adviser: David Goldberg**

GEOG 596A

PRESENTATION OVERVIEW

- Introduction

- Existing Research

- Project Objectives

- Methodology

- Expected Results

- Timeline

- Feedback and Questions

Credit: Taun Stewart

WHAT IS AN ELECTRIC VEHICLE?

▪ Uses an electric motor for propulsion

Zero emission vehicles (ZEVs)

Fuel-cell electric vehicles (FCEVs) (e.g., Toyota Mirai)

Plug-in electric vehicles (PEVs)

PEVs

Battery-electric vehicles (BEVs) (e.g., Tesla)

Plug-in hybrid electric vehicles (PHEVs) (e.g., Chevy Volt)

Credit: flickr under CC BY-NC 2.0

Credit: nakhon100 under CC BY-NC 2.0

Credit: Shelby L. Bell under CC BY 2.0

CHARGING STATION TYPES

Level 1

(1.4-1.9 kW)

Residential

$0-$3,000

Level 2

(3.4-19.2 kW)

Residential or Commercial

$1,500-$19,200

DC Fast

(50+ kw)

Commercial

$14,000-$50,000+

Credit: *Brian Patrick Tagalog*

Credit: *Ford Motor Co* under *CC BY-NC 2.0*

Credit: *Loco Steve* under *CC BY 2.0*

Credit: *Earth and Main* under *CC BY-SA 2.0*

CHARGING TIME COMPARISON

Chevy Volt (PHEV)
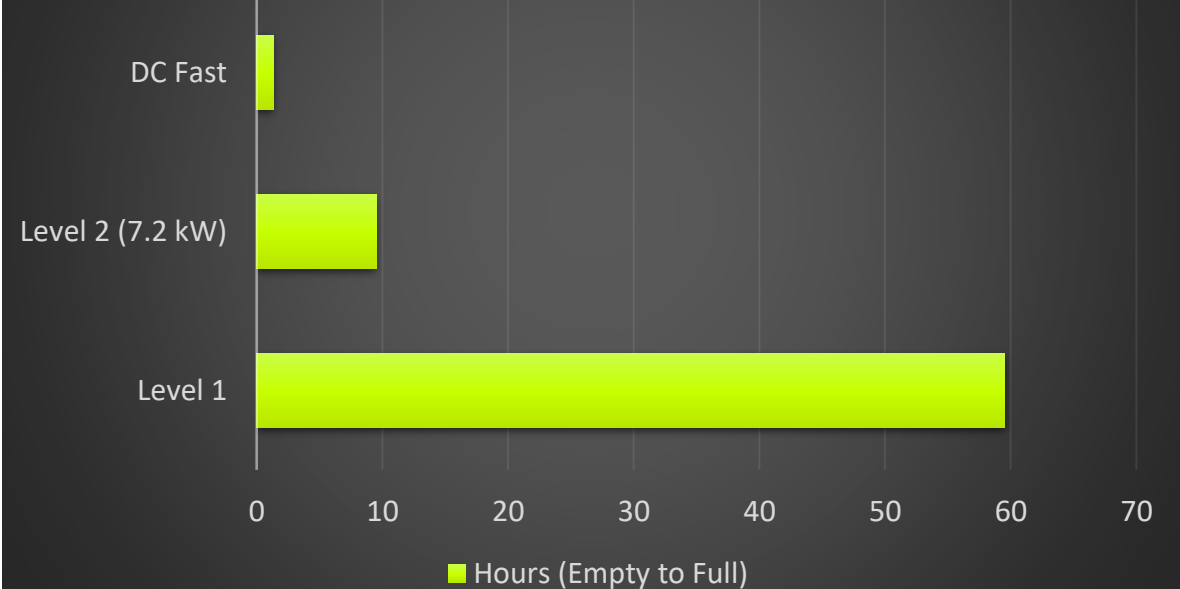### 53-mile range

Credit: *mariordo59* under *CC BY-SA 2.0*

Chevy Volt Charging Time (Hours Empty to Full)

Charger	Hours
DC Fast	0
Level 2 (7.2 kW)	~2.3
Level 2 (3.6 kW)	~4.5
Level 1	~13

Hours (Empty to Full)
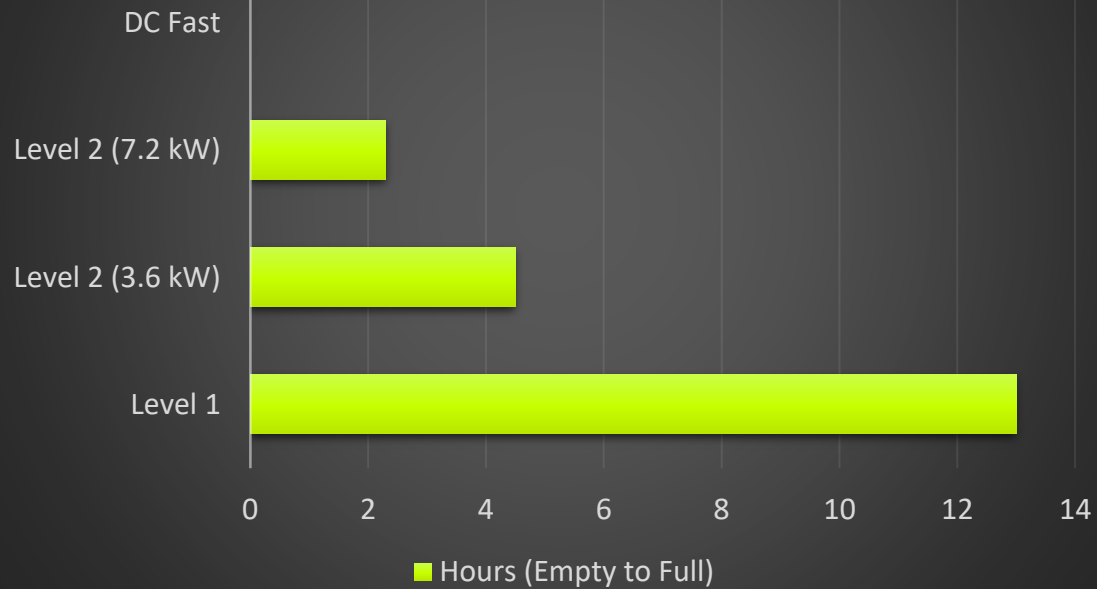
Chevy Bolt (BEV)
238-mile range

Credit: *Gregory Varnum* under *CC BY-SA 2.0*

Chevy Bolt Charging Time (Hours Empty to Full)

Charger	Hours
DC Fast	~1
Level 2 (7.2 kW)	~9
Level 1	~59

Hours (Empty to Full)

ZEV BENEFITS

- Reduce greenhouse gas (GHG) emissions

- Improve local air quality

- Reduce noise pollution

- Better performance
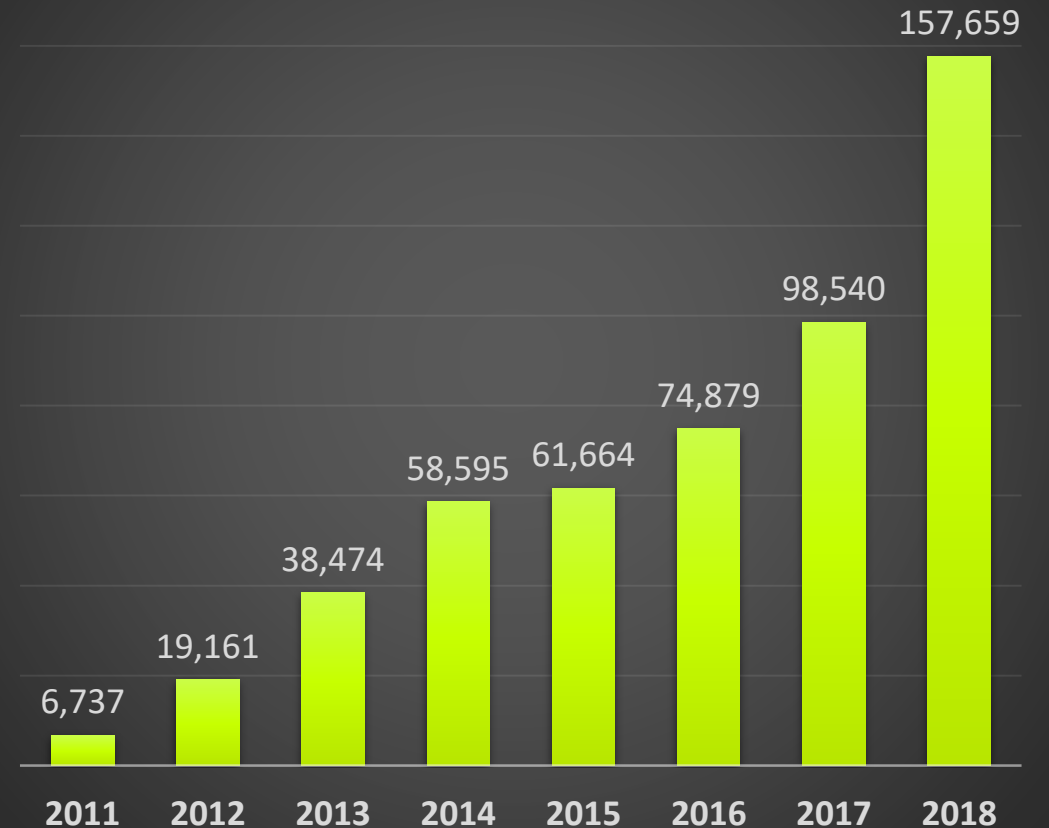
- High driver satisfaction

CALIFORNIA'S GOALS

- **April 2019**
  - 570,000 ZEVs
  - 19,800 public chargers

- **2025**
  - 1.5 million ZEVs
  - 250,000 public chargers

- **2030**
  - 5 million ZEVs

FUTURE GROWTH

- Dozens of new models in the pipeline

- Continued challenges

  - Higher purchase price

  - Relatively limited driving range

- Policy solutions

  - Financial incentives

    - Clean Vehicle Rebate Project (CVRP)

  - Expand charging infrastructure

Annual ZEV Sales in California

Year	Sales
2011	6,737
2012	19,161
2013	38,474
2014	58,595
2015	61,664
2016	74,879
2017	98,540
2018	157,659

Data compiled from Alliance of Automobile Manufacturers and Auto Outlook, Inc.

MORE PEV CHARGERS COMING ONLINE

- **New construction**
  - CALGreen building standards code
- **Public investments**
  - California Energy Commission ($95 million)
- **Private investments**
  - Investor-owned electric utilities ($600+ million)
  - Legal settlements
    - NRG Energy ($100+ million)
    - Volkswagen ($800 million)

LOS ANGELES COUNTY

- 10 million people
  - 25% of state's population
  - 20% of state ZEV market
  - + 240,000 ZEVs by 2025
  - + >23,000 public chargers by 2025
- Condominium/Apartment Buildings
  - More than 40% of county households
  - Multifamily parcels exceed 75% in some high-income areas

Credit: The City Project under CC BY-NC 2.0

- Disproportionately low PEV adoption
  - 10% of Clean Vehicle Rebate Project (CVRP) survey respondents
- Lack of home charging
  - No dedicated parking
  - Complex parking layouts
  - Challenges with HOAs/landlords

10

EXISTING RESEARCH – UCLA LUSKIN CENTER

Credit: *mariordo59* under *CC BY-SA 2.0*

- Turek and DeShazo (2016) & DeShazo et al. (2017)
  - Identified multifamily buildings suitable for PEV charger installation in areas of Los Angeles County
  - Developed model using PEV registration, household income, and home value data
  - Score assigned to parcel based on census tract and unit value
  - Score represents likelihood that household in a multifamily building would drive a PEV if charging was not an issue
  - Model assumes households living in higher-value property units have higher incomes and are more likely to drive a PEV
  - Assessed property values do not necessarily reflect market values due to Proposition 13
  - Private PEV chargers benefit fewer drivers than publicly-available chargers
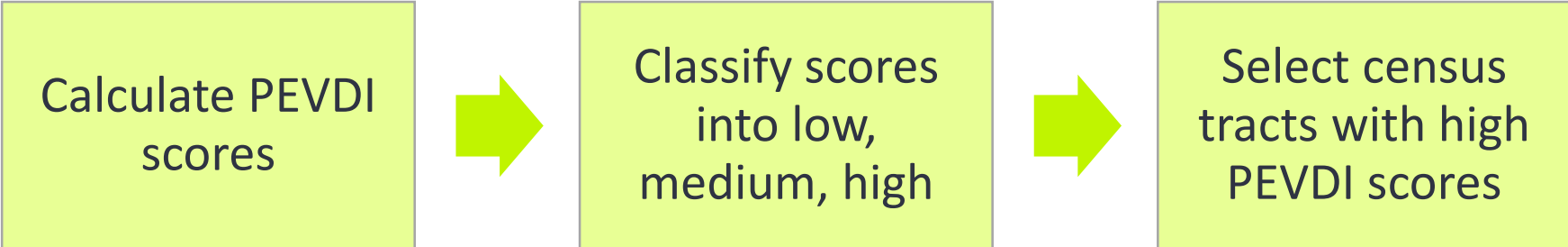
PROJECT OBJECTIVES

1. Identify census tracts in Los Angeles County where installation of publicly-available chargers could increase PEV adoption by residents of multifamily buildings

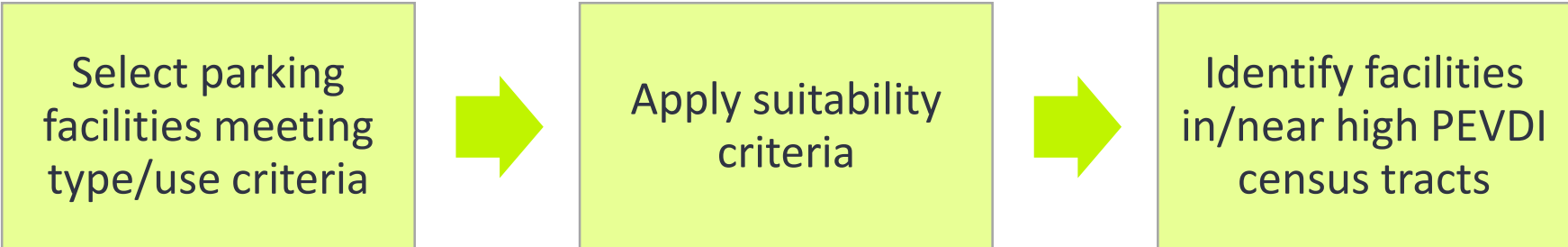2. Identify suitable parking facilities for charging station installation in or near these census tracts

Credit: Mark Turnauckas under CC BY 2.0

METHODOLOGY

PART 1

Calculate PEVDI scores → Classify scores into low, medium, high → Select census tracts with high PEVDI scores

PART 2

Select parking facilities meeting type/use criteria → Apply suitability criteria → Identify facilities in/near high PEVDI census tracts

PART 1 – METHODOLOGY

- Calculate PEV Demand Index (PEVDI) score for census tracts in Los Angeles County
  - Based on housing unit type, socioeconomic characteristics, current adoption rate of PEVs and presence of PEV chargers
  - Indicates potential for PEV adoption by residents of multifamily buildings
  - 12 variables will be normalized using either max/min value, averaged, multiplied by 100
  - PEVDI scores range from 0 to 100
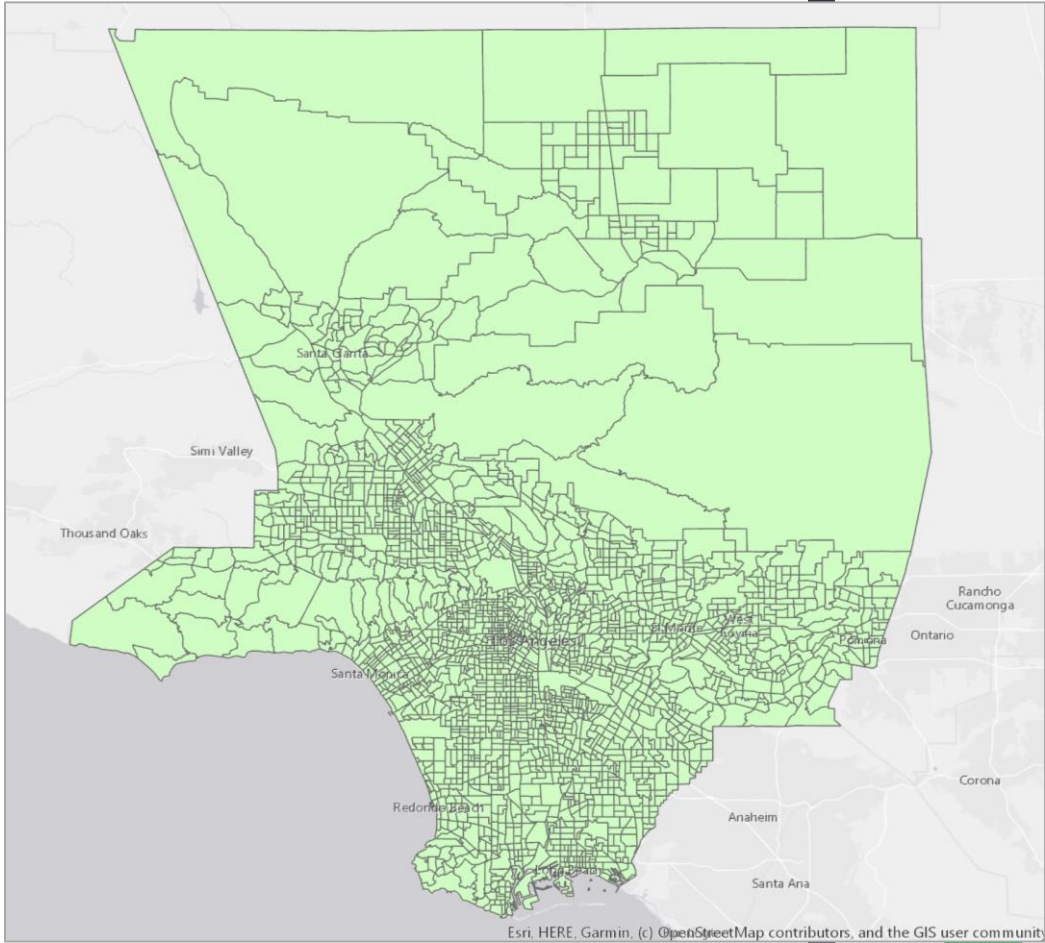
PEV DEMAND INDEX (PEVDI) SCORE

Name	Description	Rationale	Data Source
Building Type	Total number of multifamily housing units	Multifamily housing units less likely to have PEV chargers installed	LA County Assessor, 2018 Parcels
Building Size	Proportion of multifamily housing units on parcels ≥ 5 units	Higher housing unit parcel density more optimal	LA County Assessor, 2018 Parcels
Building Age	Weighted average of multifamily housing unit age	Older housing units less likely to have PEV chargers installed	LA County Assessor, 2018 Parcels
Housing Tenure	Proportion of renter-occupied housing units	Renters less likely to have access to PEV chargers	U.S. Census Bureau, 2013-2017 American Community Survey
Income	Proportion of households with MHI ≥ $100,000	CVRP survey data indicates 75% of participants w/ MHI ≥ $100,000	U.S. Census Bureau, 2013-2017 American Community Survey
Age	Proportion of population between ages of 40 and 59	CVRP survey data indicates more than 50% of participants are 40-59 years old	U.S. Census Bureau, 2013-2017 American Community Survey
Education Level	Proportion of population with at least bachelor's degree	CVRP survey data indicates more than 80% of participants have bachelor's degree or higher	U.S. Census Bureau, 2013-2017 American Community Survey

PEV DEMAND INDEX (PEVDI) SCORE

Name	Description	Rationale	Data Source
Transportation Mode	Proportion of workers traveling by car, truck, or van	Commuters using vehicles more likely to consider PEV	U.S. Census Bureau, 2013-2017 American Community Survey
Vehicle Availability	Proportion of households with 2 or more vehicles available	Households with more than one vehicle more likely to consider PEV	U.S. Census Bureau, 2013-2017 American Community Survey
Commuting Time	Mean travel time to work	Households with shorter commute times more conducive for current driving range of PEVs	U.S. Census Bureau, 2013-2017 American Community Survey
PEV Adoption	Proportion of registered PEVs to all registered vehicles	More familiarity with PEVs due to greater awareness/exposure increases likelihood of PEV adoption	California Department of Motor Vehicles, Fuel Types by ZIP Code (October 2018)
PEV Charging Infrastructure	Ratio of number of publicly-available PEV charging outlets to current number of registered PEVs	Fewer existing PEV chargers indicates greater opportunity to install charging infrastructure	Alternative Fuels Data Center, U.S. Department of Energy

PART 1 – SOFTWARE APPLICATIONS

- *Geopandas* Python data library
  - LA County Assessor parcel data (2 million+ parcels)
- ArcGIS Pro
  - Data Preparation
    - U.S. Census Bureau – minimal
    - CA DMV – reaggregate data from zip code level to census tract level
    - AFDC, U.S. Department of Energy – spatial join of point data to census tract polygons
  - Calculate PEVDI scores
  - Classify scores using natural breaks method
   - High, medium, low
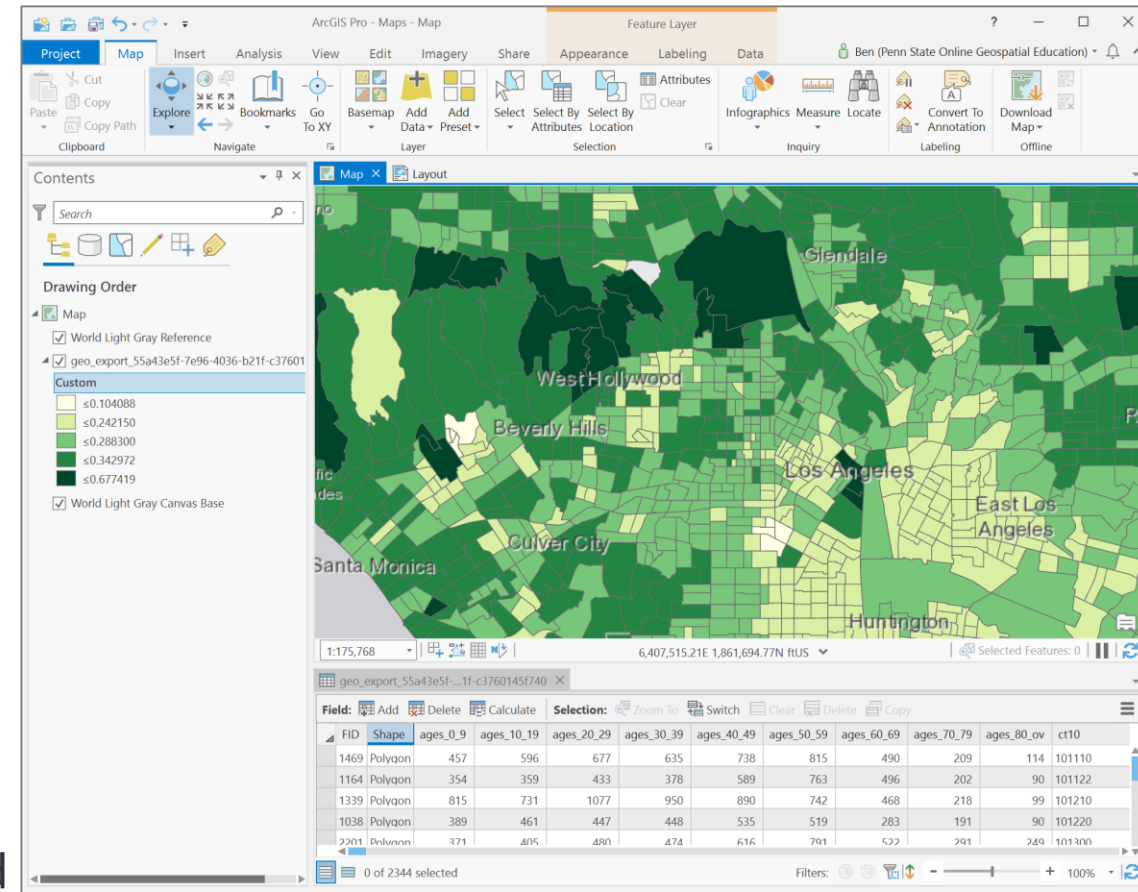
PART 2 – METHODOLOGY

- ArcGIS Pro – Select facilities from LA County parking dataset meeting use type/description criteria

Charging Station Type	Use Type	Use Description	LA County Location Management System (LMS) Category
Level 2	Commercial	Commercial, Department Stores, Parking Lots (Commercial Use Properties), Restaurants, Cocktail Lounges, Shopping Centers (Regional)	
	Government	Government Parcel	Adult Education, Airports, Colleges and Universities, Courthouses, Libraries, Historical Parks, Metro Stations, Metrolink Stations, Museums and Aquariums, Park and Ride Locations, Parks and Gardens, Pools, Recreation Centers
	Institutional	Churches	
	Recreational	Athletic & Amusement Facilities, Bowling Alleys, Camps, Clubs, Lodge Halls, Fraternal Organizations, Golf Courses, Race Tracks, Recreational, Skating Rinks, Theaters, Water Recreation	
DC Fast	Commercial	Banks Savings & Loan, Service Stations, Shopping Centers (Neighborhood, community), Store Combination, Stores, Supermarkets	
	Government	Government Parcel	City Halls, County Offices, Government Offices, Post Offices

PART 2 – METHODOLOGY

- Apply suitability criteria to parking facilities
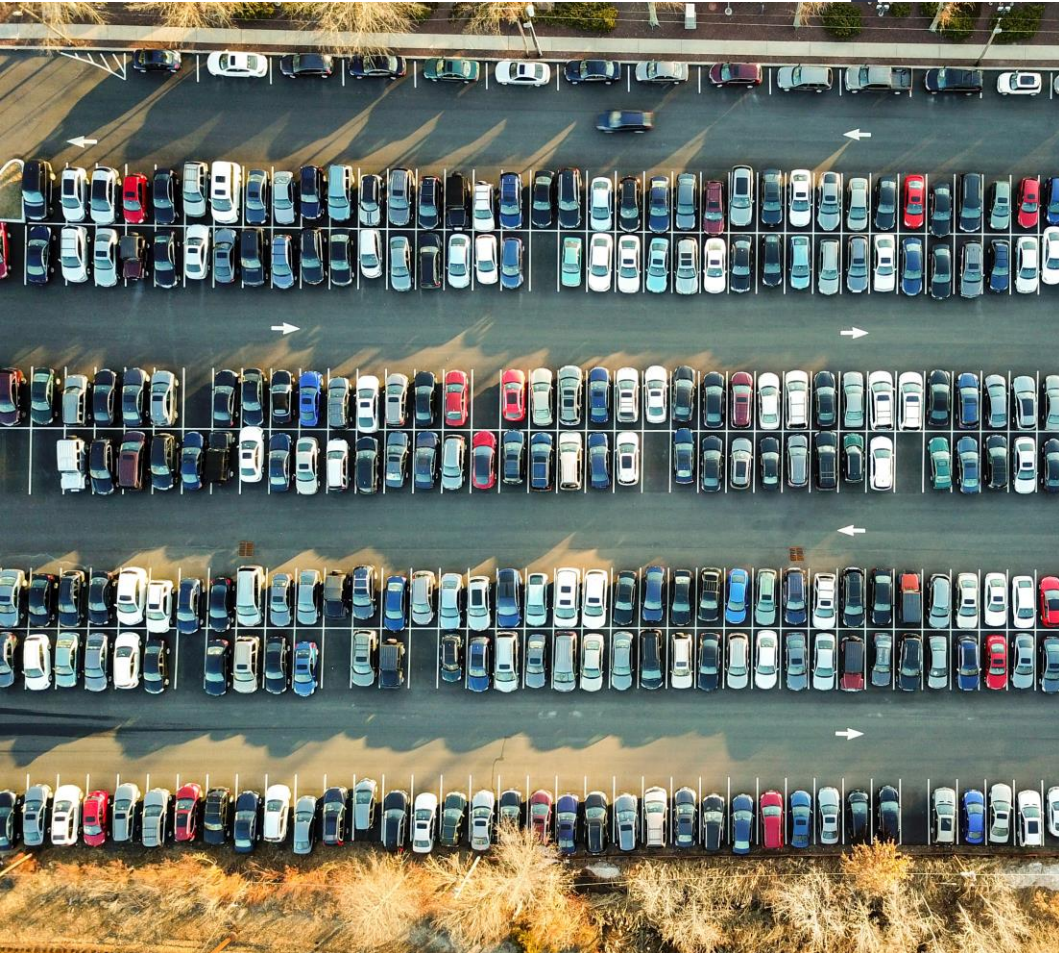
Criterion	Description	Rationale	Source Dataset
Existing PEV Chargers	Eliminates parking facilities if PEV chargers are currently installed	Assumes that existing PEV chargers are enough to meet current demand	Alternative Fuels Data Center, U.S. Department of Energy
Convenience	Facility is suitable only if within 1 mile of primary or secondary roads	Assumes that a facility will be more useful for PEV drivers if easily accessible by major roads	Los Angeles County, Countywide Address Management System (CAMS)
Flood Risk	Eliminates parking facilities located in FEMA-designated Special Flood Hazard Areas (SFHAs) (i.e., A and V zones)	Facilities in these high-risk areas are more susceptible to flooding and should be avoided	Federal Emergency Management Agency (FEMA), National Flood Hazard Layer

Credit: Omer Rana

Credit: *Mike* under *CC BY-SA 2.0*

PART 2 – METHODOLOGY

- Create buffers of 0.5, 2.5, and 5 miles around census tracts with high PEVDI scores

- Intersect buffers with parking facilities meeting suitability criteria

EXPECTED RESULTS

- Los Angeles County census tracts categorized into low, medium, high potential for increasing PEV adoption by multifamily residents

- Lists of candidate facilities in/near census tracts for Level 2 and DC Fast charger installation

TIMELINE

- May – June 2019
  - Finalize proposal
  - Finish Part 1 – Prep data for PEVDI variables, calculate PEVDI scores, classify census tracts by score

- July – August 2019
  - Finish Part 2 – Filter parking facilities, intersect with buffers
  - Begin writing final paper

- September 2019
  - Finish paper
  - Develop presentation

- October or November 2019
  - Capstone Project presentation

Credit: Dale Cruse under CC BY 2.0

QUESTIONS?

THANK YOU!