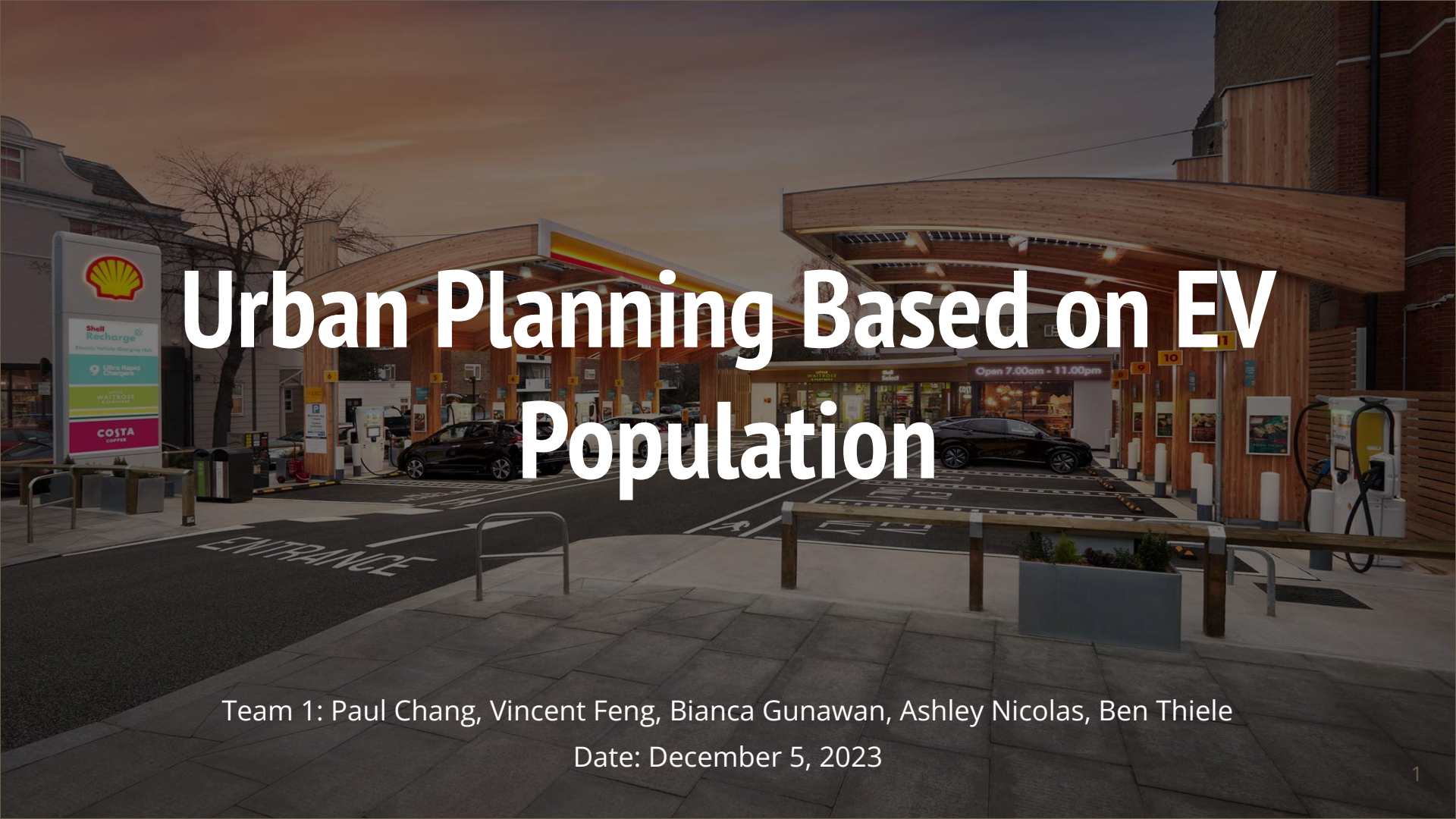


Urban Planning Based on EV Population

Team 1: Paul Chang, Vincent Feng, Bianca Gunawan, Ashley Nicolas, Ben Thiele

Date: December 5, 2023

Executive Summary

Overarching Goal

Explore where to build EV Chargers

Methodology

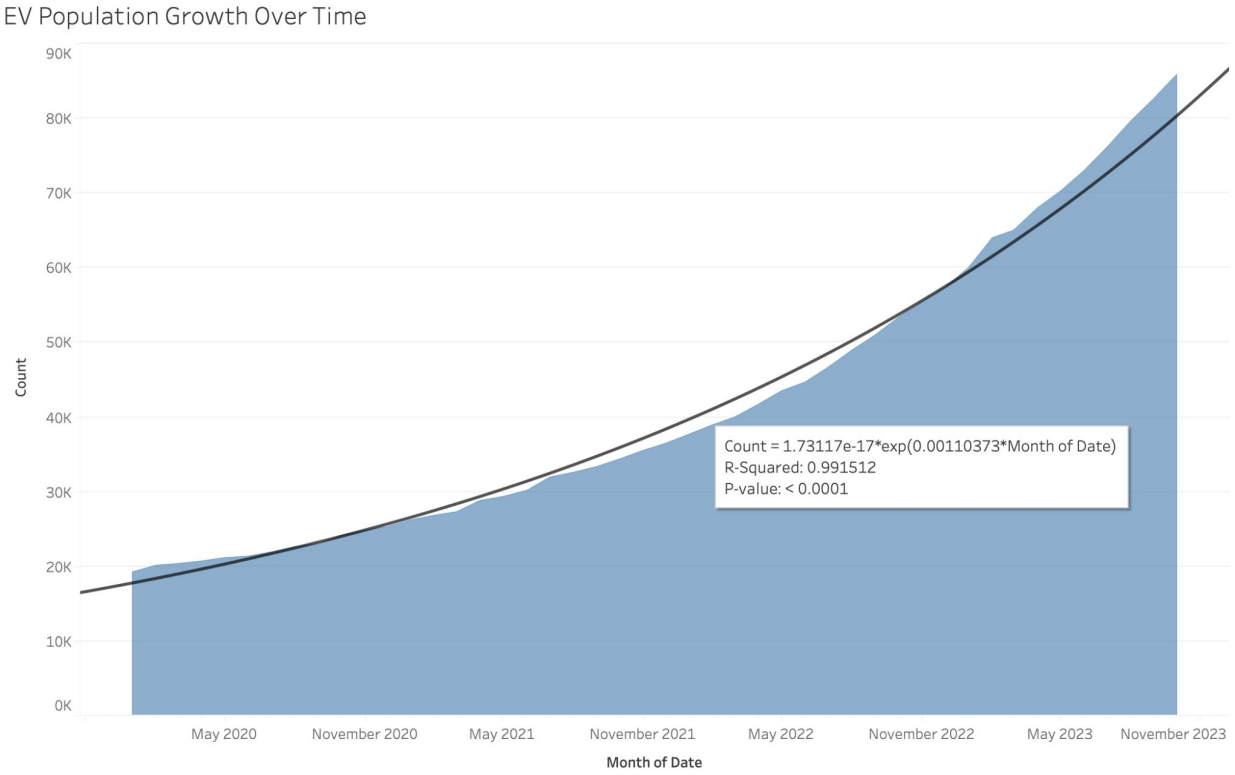
Datasets: EV Registrations, Charging Stations, Demographic Data

Data Model: Dimensional Modeling with Star Schema

Recommendations

Built a dynamic dashboard

Business Case: Clear Need for EV Infrastructure Planning



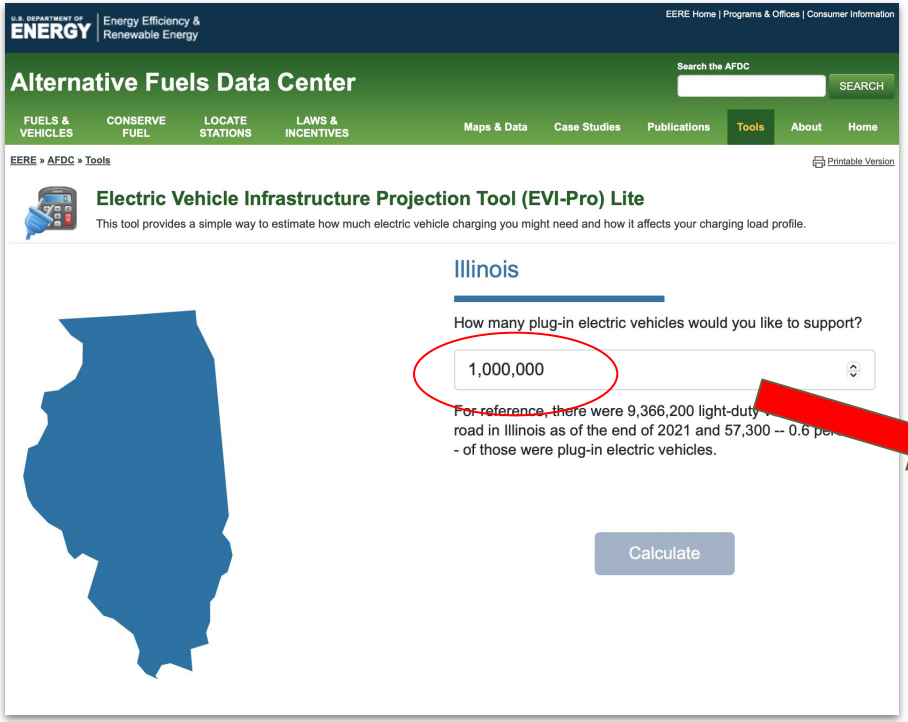
Demand

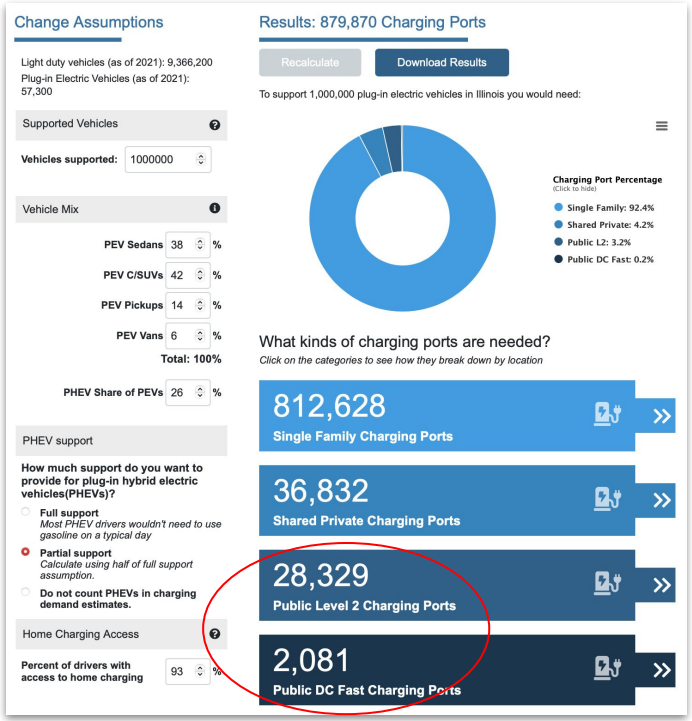
- Exponential growth in EVs
- State of IL has set a 1M EV target by 2030

Supply

- Where to build EV Infrastructure

Recommended Number of Integrated EV Chargers





So Much Infrastructure Yet to be Built

Public Level 2/DC Fast Charger Count Needed by 2030

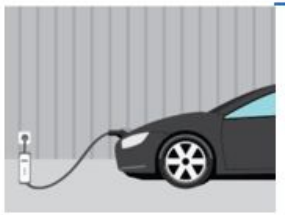
30,000

Public Level 2/DC Fast Charger Count as of July 2022

2,800

Jul 2022 EV Population = 50,000

Types of EV Chargers

		Range	Application
Level 1		2 to 5 miles of range per hour	• Single Family Homes • Multi-Unit Residential • Condos
Level 2		10 to 30 miles of range per hour	• Single Family Homes • Multi-Unit Residential • Workplace • Fleet • Public
Level 3 (Direct Current Fast)		150 to 350+ miles of range per hour	• Fleet • Public • Multi-Unit Residential

Overview of Datasets

EV POPULATION

- Total EV registrations in Illinois
- Zip code granularity
- 2020 - 2022

CENSUS DATA

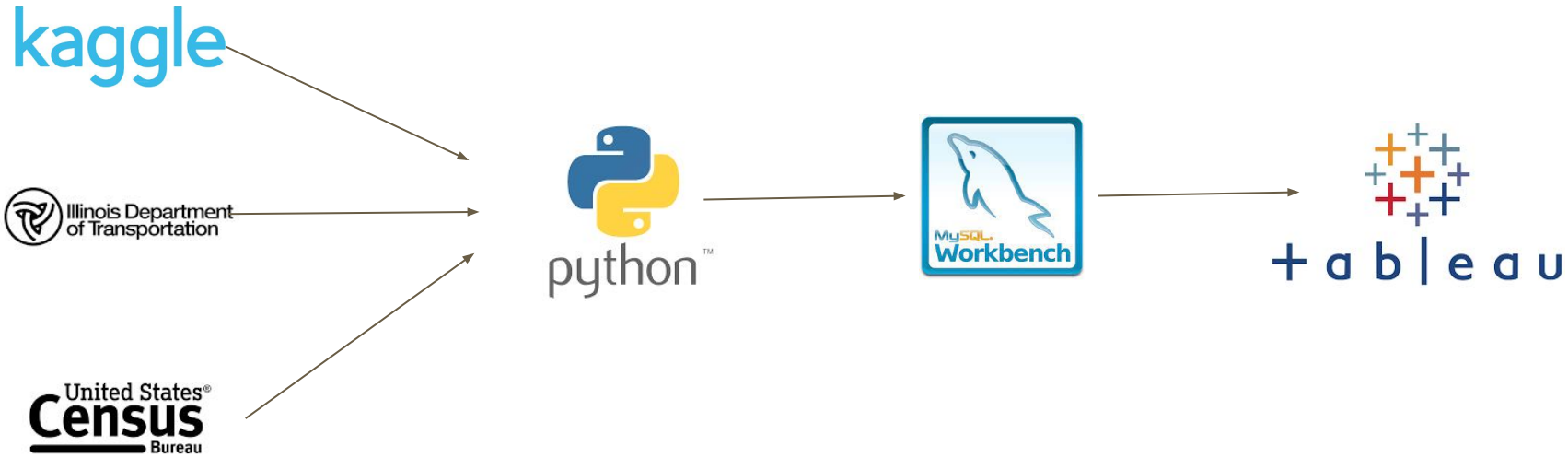
- Demographic data on race/ethnicity, educational attainment, income
- Zip Code Granularity
- 2021 ACS 5-year estimates
  - Best estimates for areas with populations < 65,000

CHARGING STATIONS

- Count of charging stations & chargers at each station
- Street address granularity
- 2023
- Type of Chargers:
  - Level 1
  - Level 2
  - DC Fast

End-to-End Design

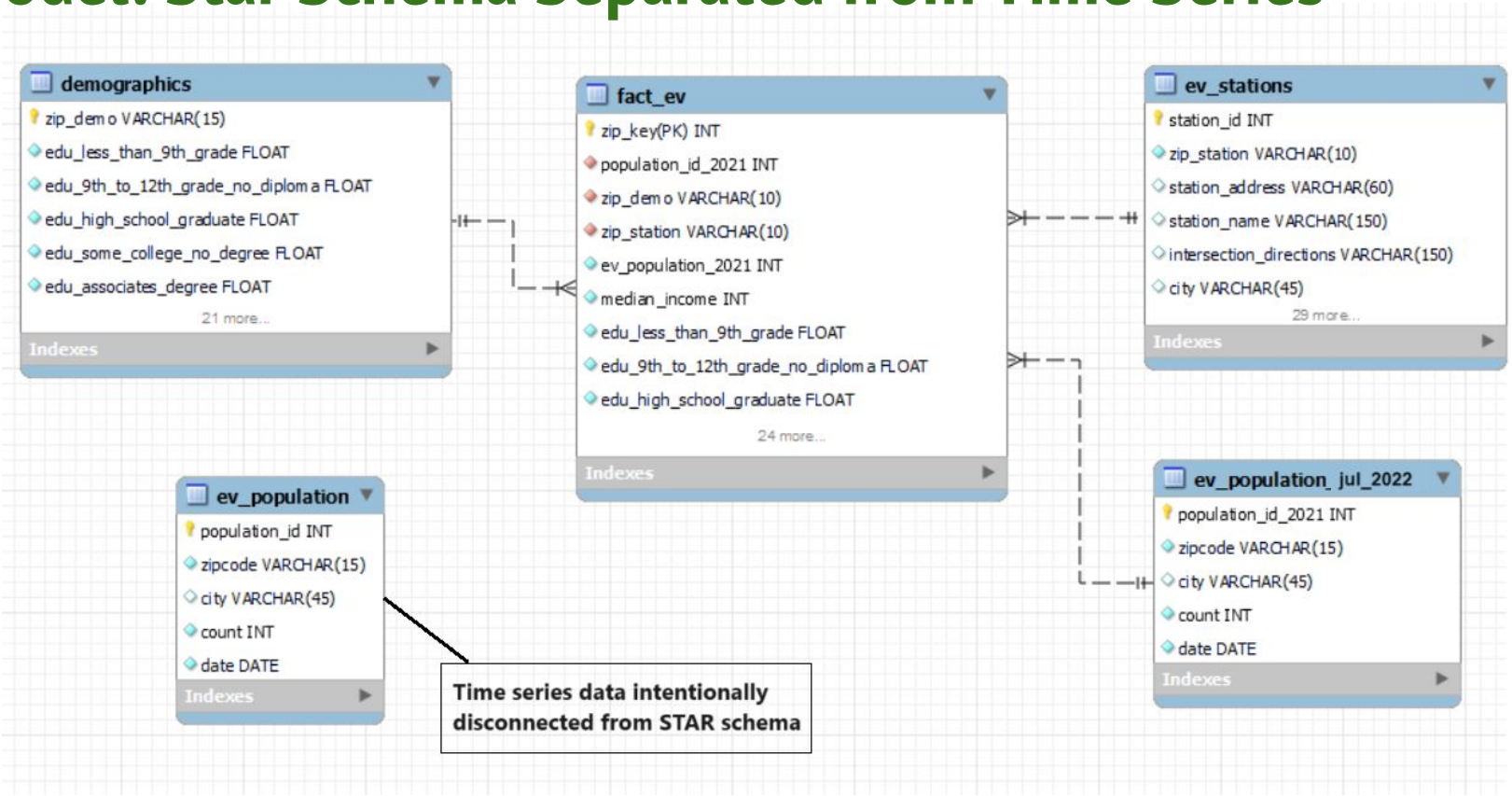
Data Source **Cleaning** **Load** **Visualization**



Data Cleaning & Quality

- Reduced Charger Station data from a North American scope to Illinois only
- Filter for Electric Charging Stations
- Cleaned data types for joins and analysis
- Checked for missing values; kept missing values for types of chargers
- Replaced null median income values with state median
- Renamed columns with consistent formatting
- Changed data types to improve efficiency

Model: Star Schema Separated from Time Series

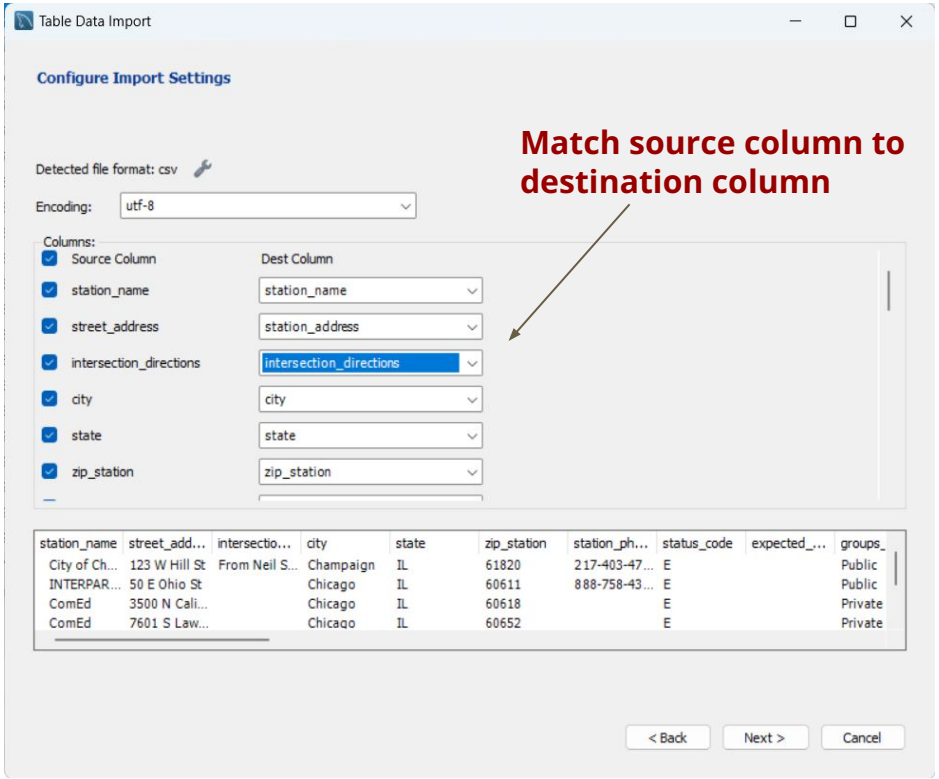


Source to Target Mapping

- Target table: fact_ev
- Source tables: ev_population_jul_2022, ev_stations, demographics

Source		**Transformation**	**Target**	
Source Table	Source Column	Logic	Target Column	Comments
ev_stations	zip_station	N/A	zip_station	FK
demographics	edu_bachelors_degree	N/A	edu_bachelors_degree	-
ev_population_jul_2022	count	N/A	ev_population_2022	-
ev_stations	ev_level2_evse_num	SUM, GROUP BY zip_station	count_level_2_chargers	Zipcode-level aggregation

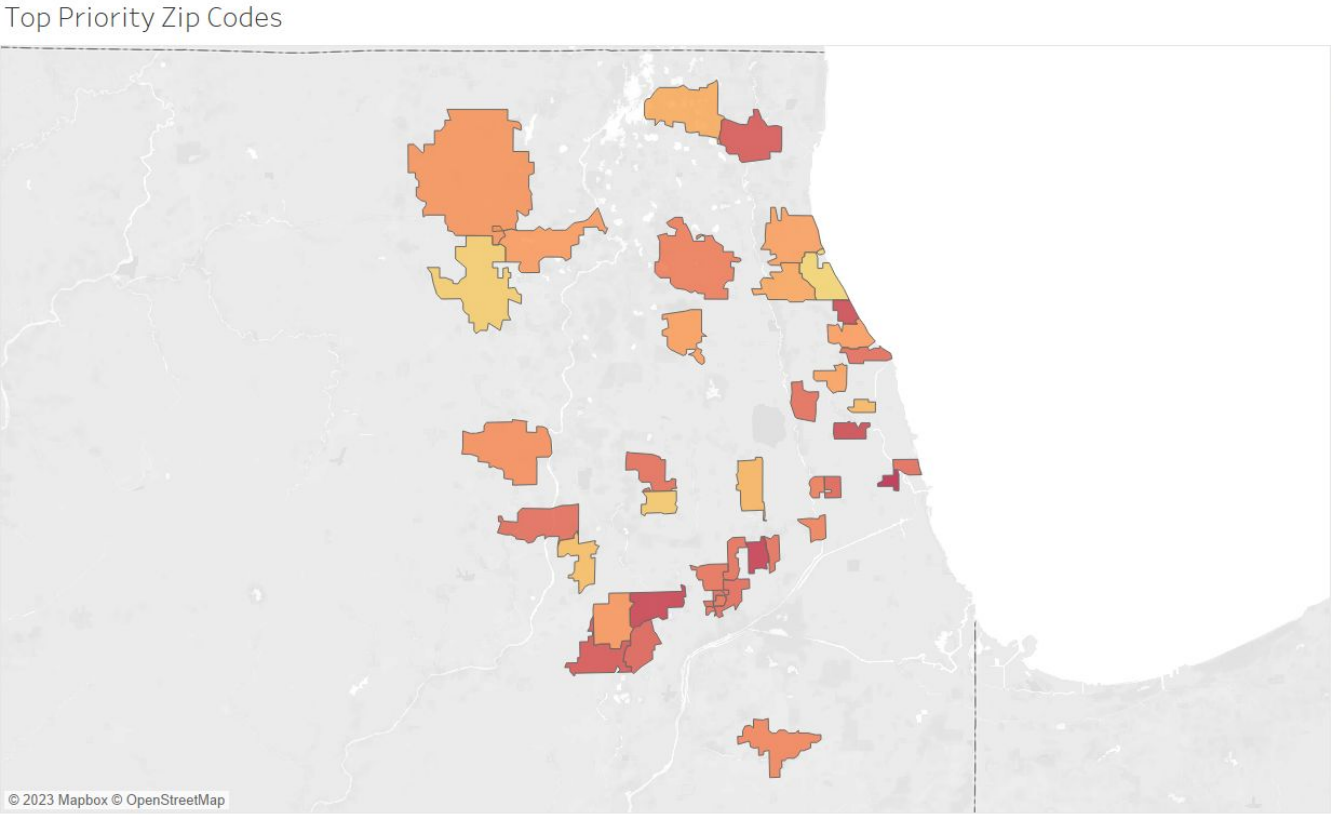
Load: Import Wizard and "Insert Into"




```
80      dm.age_pct_15_to_19_yrs,
81      dm.age_pct_20_to_24_yrs,
82      dm.age_pct_25_to_34_yrs,
83      dm.age_pct_35_to_44_yrs,
84      dm.age_pct_45_to_54_yrs,
85      dm.age_pct_55_to_59_yrs,
86      dm.age_pct_60_to_64_yrs,
87      dm.age_pct_65_to_74_yrs,
88      dm.age_pct_76_to_84_yrs,
89      dm.age_pct_85_and_older,
90      COALESCE(sum(st.ev_level2_evse_num), 0),
91      COALESCE(sum(st.ev_dc_fast_count), 0)
92  FROM ev_schema.demographics dm
93  INNER JOIN ev_schema.ev_stations st
94      ON dm.zip_demo = st.zip_station
95  INNER JOIN ev_population_jul_2022 ep
96      ON ep.zipcode = st.zip_station
97  GROUP BY ep.population_id_2022, st.zip_station, dm.zip_demo, ep.zipcode;
```

Join by zip code and group by zip code to ensure fact table has uniform level of aggregation

Top Priority Zip Codes



Map based on Longitude (generated) and Latitude (generated). Color shows sum of Chargers_Per_Person. Details are shown for Zip Demo. The data is filtered on sum of Median Income, sum of Edu Graduate Or Professional Degree and sum of Ev Population 2022. The sum of Median Income filter includes values greater than or equal to 79,000. The sum of Edu Graduate Or Professional Degree filter includes values greater than or equal to 10.9. The sum of Ev Population 2022 filter includes values greater than or equal to 100. The view is filtered on sum of Chargers_Per_Person, which includes values less than or equal to 0.03000.

High Priority Criteria:

- High EV Population Growth Rate
- High Education Level
- High Median Income
- Charger-to-EV Ratio is below recommended amount (0.03)
- Minimum 100 EVs

Recommendations, Insights

- Recommendations
  - Gas station companies can filter results based on the company's goals (e.g. target locations with higher middle-income classes, target locations with higher EV population)
  - Start installing new charging ports in the 'Top Priority' zip codes

- Additional Data / Next Steps
  - Include gas station brands, locations, customer traffic, etc. for improved search efficiency of ideal, pre-existing gas station locations
  - Frequent routes between metros could be used to more accurately target rural areas for EV charging infrastructure
  - Gov't can require charger standardization among EV companies with Tesla's proprietary North American Charging Standard (NACS)

Lesson Learned

Data Engineering Lessons:

- **Incongruities in time element of multiple datasets**
- **Import wizard & troubleshooting**
  - **Date formats**
  - **Null values**

Data Analysis Lessons:

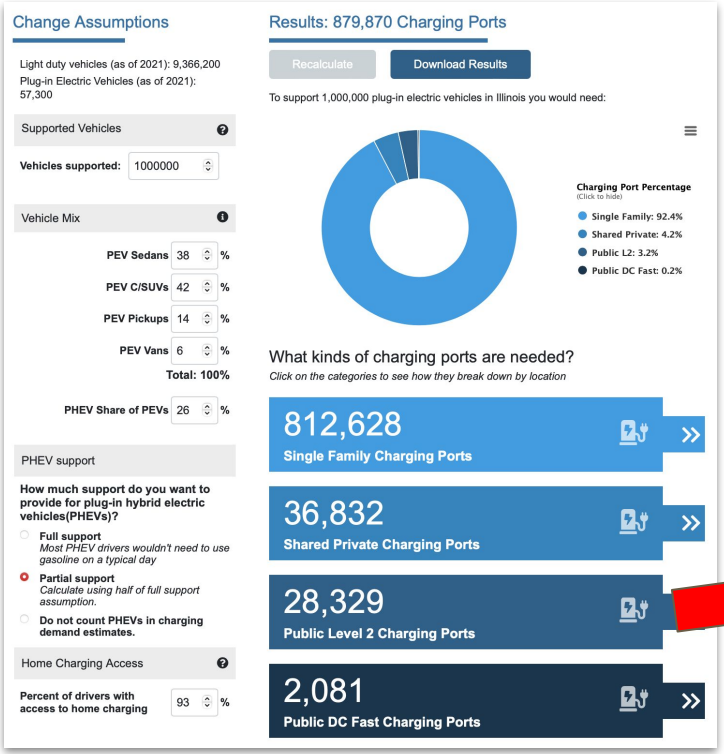
- **The most important data, charging station usage data is locked behind a paywall**
- **We need insights on common commuter routes**
- **How do we account for tourist EV charging station usage?**
- **Charging station U**

References

- **Recommended Number of Integrated EV Chargers:** https://afdc.energy.gov/evi-pro-lite
- **EV Population (Sales) Dataset:** www.ilsos.gov/departments/vehicles/statistics/electric/home.html
- **EV Charging Station Dataset:** www.kaggle.com/datasets/saketpradhan/electric-and-alternative-fuel-charging-stations/
- **Demographics - Income Dataset:** https://data.census.gov/table/ACSDP5Y2021.DP03?q=DP03:+SELECTED+ECONOMIC+CHARACTERISTICS&t=Income+and+Poverty&g=040XX00US17$8600000
- **Demographics - Education Dataset:** https://data.census.gov/table/ACSDP1Y2021.DP02?q=DP02:+SELECTED+SOCIAL+CHARACTERISTICS+IN+THE+UNITED+STATES
- **Demographics - Age Bracket & Ethnicity Dataset:** https://data.census.gov/table/ACSDP5Y2021.DP05?q=DP05:+ACS+DEMOGRAPHIC+AND+HOUSING+ESTIMATES&t=Age+and+Sex:Race+and+Ethnicity&g=010XX00US$8600000

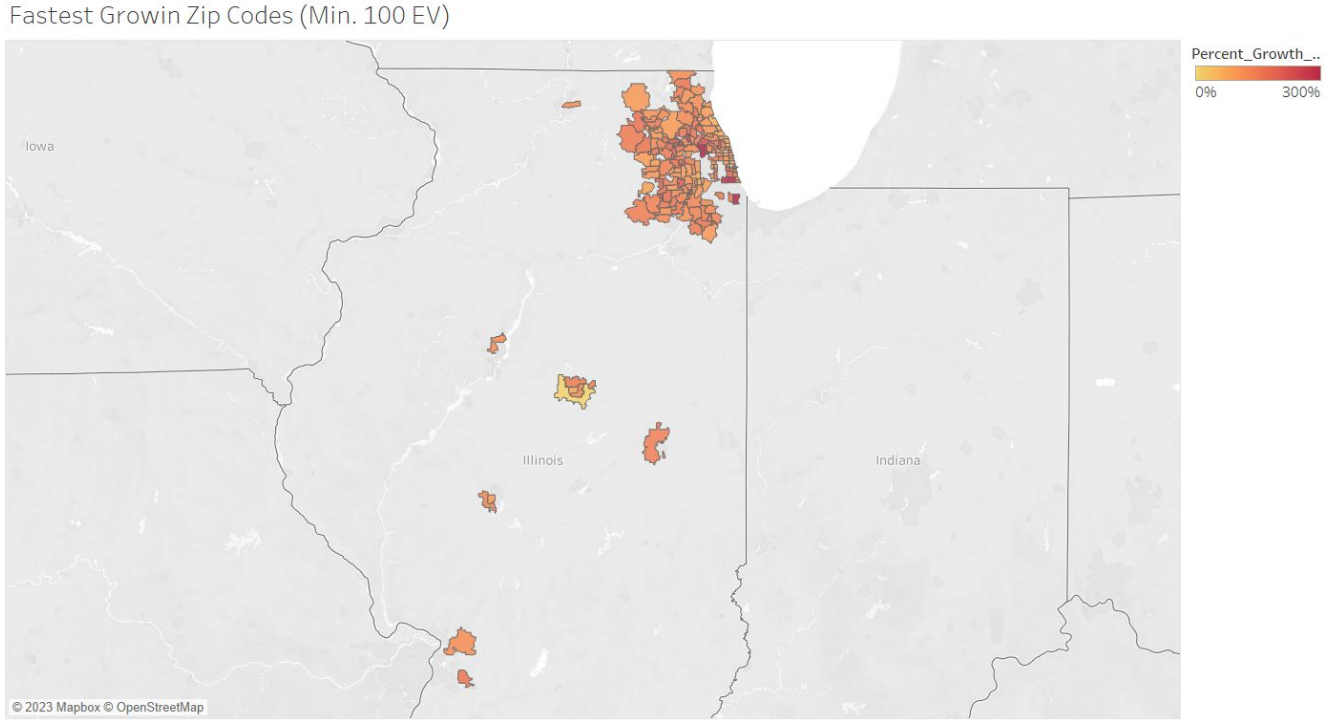
Live Demo

Appendix


Change Assumptions
Light duty vehicles (as of 2021): 9,366,200
Plug-in Electric Vehicles (as of 2021): 57,300
Supported Vehicles
Vehicles supported: 1000000
Vehicle Mix
PEV Sedans 38 %
PEV C/SUVs 42 %
PEV Pickups 14 %
PEV Vans 6 %
Total: 100%
PHEV Share of PEVs 26 %
PHEV support
How much support do you want to provide for plug-in hybrid electric vehicles(PHEVs)?
Full support
Most PHEV drivers wouldn't need to use gasoline on a typical day
Partial support
Calculate using half of full support assumption.
Do not count PHEVs in charging demand estimates.
Home Charging Access
Percent of drivers with access to home charging 93 %
Results: 879,870 Charging Ports
Recalculate
Download Results
To support 1,000,000 plug-in electric vehicles in Illinois you would need:
Charging Port Percentage
(Click to hide)
Single Family: 92.4%
Shared Private: 4.2%
Public L2: 3.2%
Public DC Fast: 0.2%
What kinds of charging ports are needed?
Click on the categories to see how they break down by location
812,628
Single Family Charging Ports
36,832
Shared Private Charging Ports
28,329
Public Level 2 Charging Ports
2,081
Public DC Fast Charging Ports

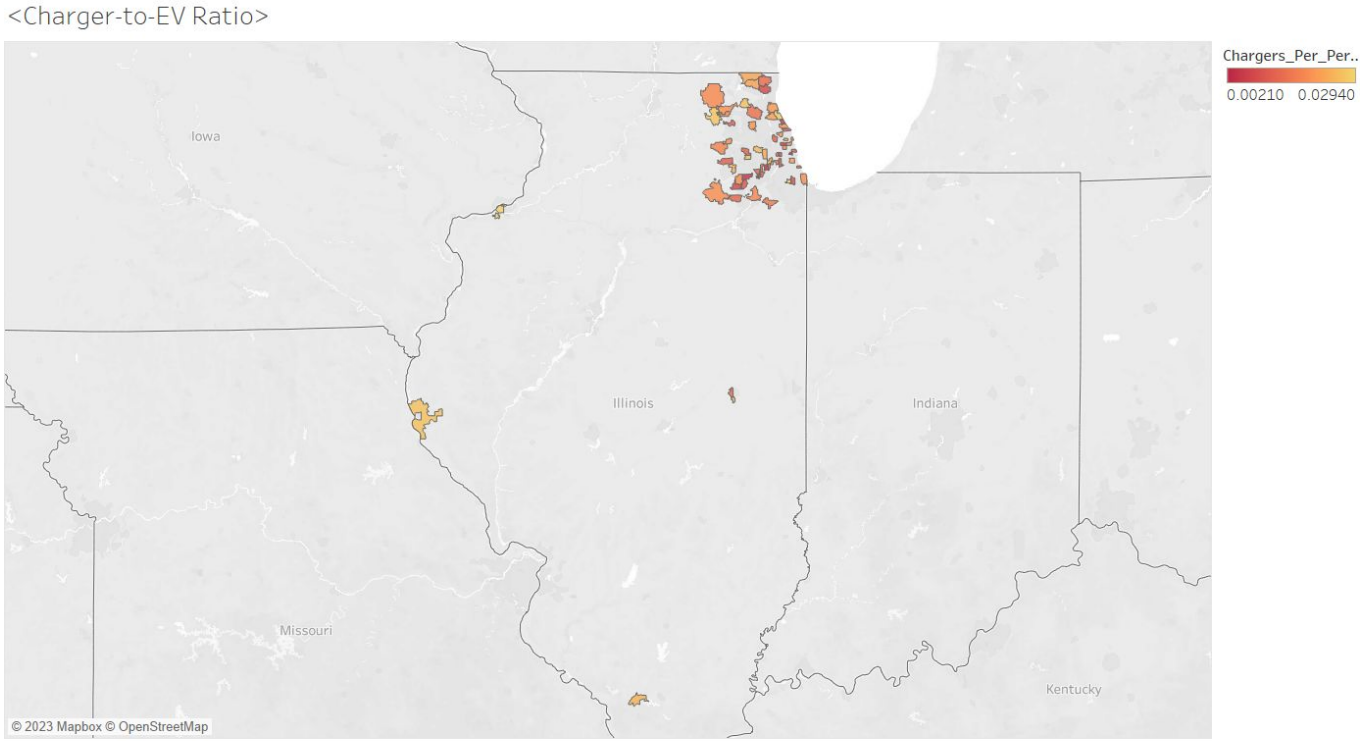

28,329 Public Level 2 Charging Ports
3,543 Retail Level 2 Charging Ports
1,528 Recreation Center Level 2 Charging Ports
2,374 Healthcare Facility Level 2 Charging Ports
1,504 Education Facility Level 2 Charging Ports
1,113 Community Center Level 2 Charging Ports
2,199 Transportation Facility Level 2 Charging Ports
10,729 Neighborhood Level 2 Charging Ports
5,339 Office Level 2 Charging Ports

EV Population Growth Rate by Zip Code



Calculated as growth rate between Jan-2022 and Oct-2023

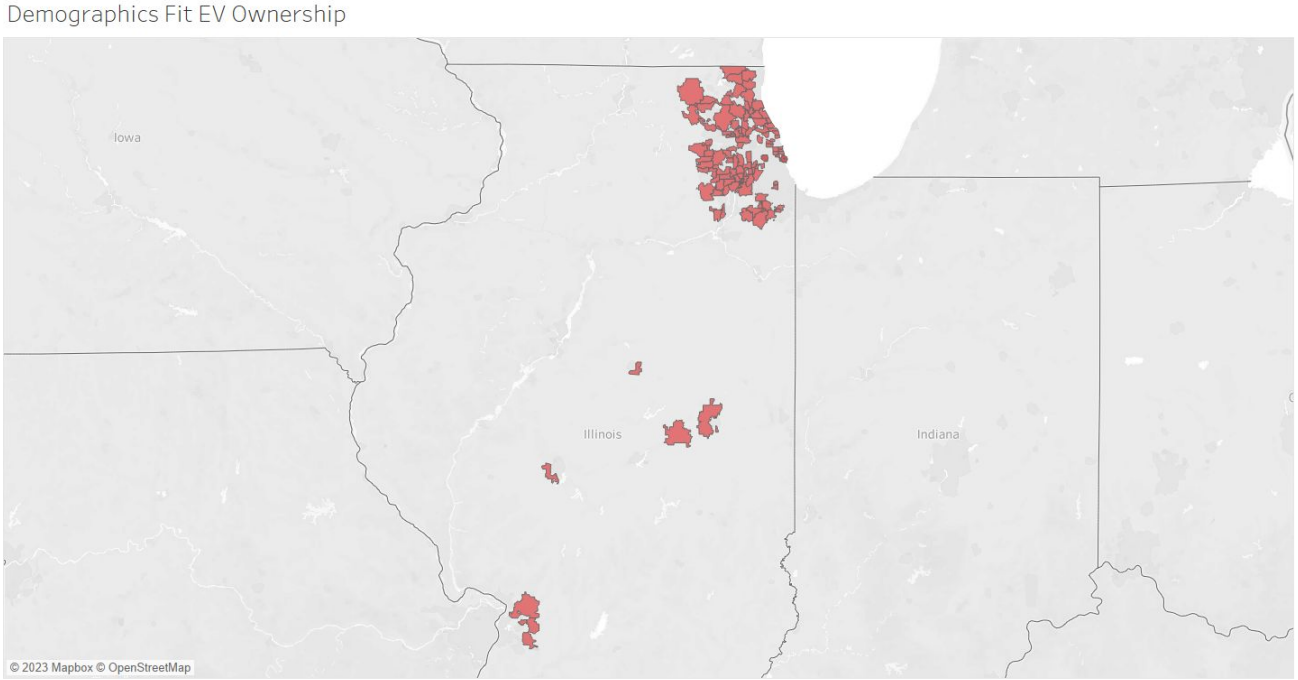
Zip Codes Below Recommended Charger-to-EV Ratio



Map based on Longitude (generated) and Latitude (generated). Color shows sum of Chargers_Per_Person. Details are shown for Zip Demo. The view is filtered on sum of Chargers_Per_Person, which includes values less than or equal to 0.03000.

Dept. of Energy recommends approximately 0.03 charging ports per 1 EV

Zip Codes where Demographics are Most Suited for EV Ownership



Map based on Longitude (generated) and Latitude (generated). Details are shown for Zip Demo. The data is filtered on sum of Median Income and sum of Edu Graduate Or Professional Degree. The sum of Median Income filter includes values greater than or equal to 79,000. The sum of Edu Graduate Or Professional Degree filter ranges from 10.9 to 66.099998474.

These Zip Codes are in the top 25th percentile of both median income and proportion of population with a graduate degree