# Electric Cars

## STAT184 FINAL PROJECT PROGRESS REPORT

Eric, Owen, VK

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# OUR FINAL PROJECT

Our group wanted to examine Electric Vehicles (EV's). We found datasets concerning car brands, charging stations, and EV usage overtime..

- We came up with five data analysis questions, and also found an interesting outlier vehicle to compare and contrast with.

# DATA ANALYSIS QUESTIONS

- Question 1: How common are charging stations?
  - We will create a Leaflet map to find the charging stations in Pennsylvania.
- Question 2: What vehicle has the longest excursion time/length on a full-charge?
  - We will create a scatter plot to examine this relationship. (NYI)
- Question 3: What is the most cost-efficient car? What would you buy if you had just graduated? (NYI)
- Question 4: How has global EV usage changed over the years?
  - We will create a bar plot of EV usage each year.
- Question 5:
  - We will create a bar plot of EV usage by country.

# CHARGING STATIONS IN PENNSYLVANIA

## How many charging stations are in PA? Where are they located?

**Alternative Fuel Stations 2021.csv**

Download

More Details

URL: https://data.openei.org/files/106/alt_fuel_stations%20%28Jul%2029%202021%29.csv

A "snapshot" of the alternative fueling station information for compressed natural gas (CNG), E85 (85% ethanol, 15% gasoline), propane/liquefied petroleum gas (LPG), biodiesel, electricity, hydrogen, and liquefied natural gas (LNG), as of July 29, 2021.

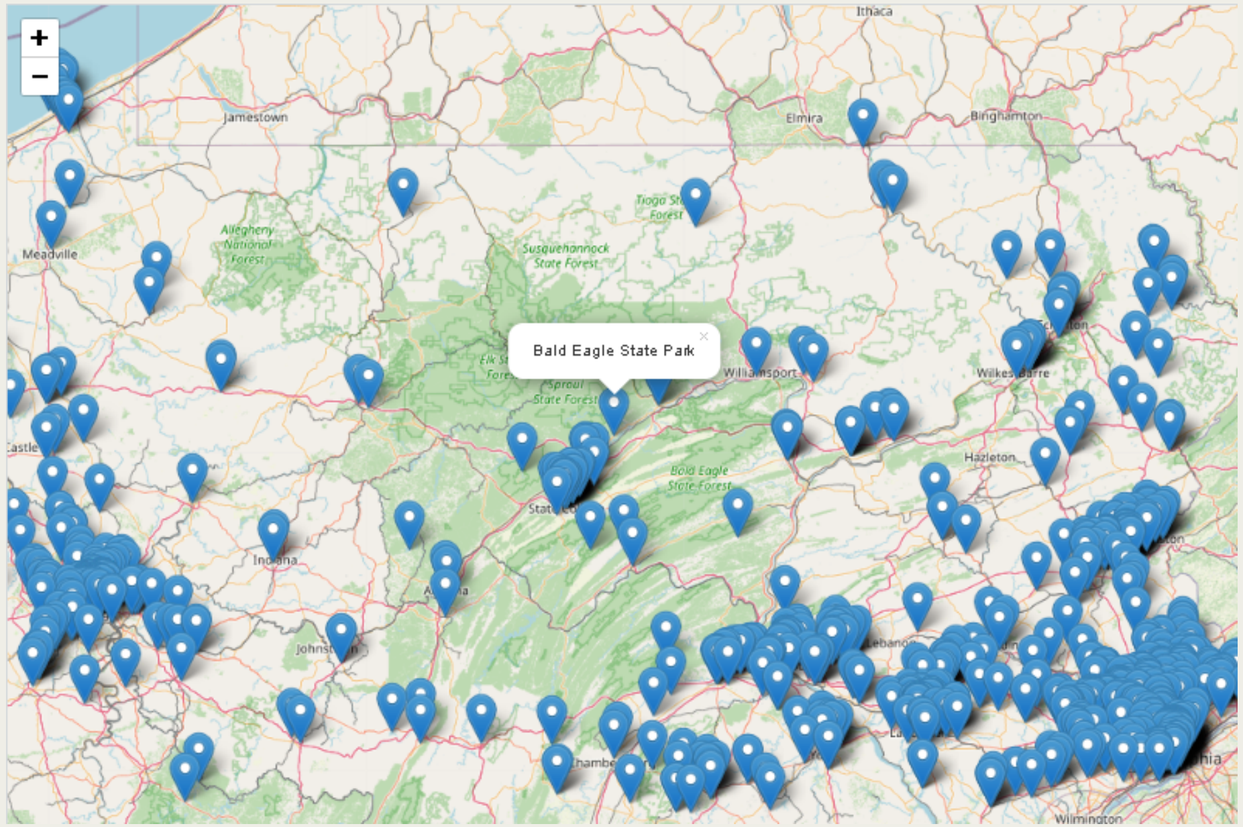
Source: Alternative Fueling Station Locations

| Fuel Type Code | Station Name | Street Address | Intersection Direc | City | State | ZIP |
|---|---|---|---|---|---|---|
| CNG | Spire - Montgom | 2951 Chestnut St | | Montgomery | AL | 36107 |
| CNG | PS Energy - Atla | 340 Whitehall St | From I-7585 N, e | Atlanta | GA | 30303 |
| CNG | Metropolitan Atla | 2424 Piedmont Rd NE | | Atlanta | GA | 30324 |
| CNG | United Parcel Se | 270 Marvin Miller Dr | | Atlanta | GA | 30336 |
| CNG | Clean Energy - T | 7721A Washingt | I-10, Washington | Houston | TX | 77007 |
| CNG | Arkansas Oklaho | 2100 S Waldron Rd | | Fort Smith | AR | 72903 |
| CNG | Clean Energy - L | 1000 Cottage St | From Route 1, ta | East Boston | MA | 2128 |

| 1 | Fuel Type Code | Station Name | City | State | Groups With Access Code | Latitude | Longitude |
|---|---|---|---|---|---|---|---|
| 161 | ELEC | LADWP - Truesdale Center | Sun Valley | CA | Private | 34.24831915 | -118.3879714 |
| 162 | ELEC | LADWP - West LA District Office | Los Angeles | CA | Private | 34.052542 | -118.448504 |
| 163 | ELEC | Southern California Edison - Rosemead Office B | Rosemead | CA | TEMPORARILY UNAVAILAB | 34.050745 | -118.081014 |
| 164 | ELEC | Los Angeles Convention Center | Los Angeles | CA | Public | 34.040539 | -118.271387 |
| 165 | ELEC | LADWP - John Ferraro Building | Los Angeles | CA | Private | 34.059133 | -118.248589 |
| 166 | ELEC | LADWP - Haynes Power Plant | Long Beach | CA | Private | 33.759802 | -118.096665 |
| 167 | ELEC | State Capitol Parking Garage | Sacramento | CA | Private - Government only | 38.576769 | -121.495022 |
| 168 | ELEC | LADWP - Harbor Generating Station | Wilmington | CA | Private | 33.770508 | -118.265628 |

# CHARGING STATIONS IN PENNSYLVANIA

```
#----------------------
#-Data Visualizations-
#----------------------
##1. How common are charging stations?
#

## Use groundhog to make sure the code runs mostly everywhere
library(groundhog)
groundhog.day="2023-11-20"

## 'here' for using a relative filepath
## 'leaflet' will display the map of charging stations
## 'dplyr' is brought in for tidying data
pkgs=c('here', 'leaflet', 'dplyr')
groundhog.library(pkgs, groundhog.day)

## Using 'here' for a relative filepath
csv_path <- here("EVfuelstations.csv")
EVfuelstations <- read.csv(csv_path)

## This dataset includes a column called "Fuel Type Code" that can stand for electric, CNG, etc
## We want to only consider the fuel stations that are ELEC, in Pennsylvania, and for public use
filtered_stations <- EVfuelstations %>% filter(Fuel.Type.Code == "ELEC") %>%
  filter(State == "PA") %>% filter(Groups.With.Access.Code == 'Public')

num_stations = nrow(filtered_stations)

print("Number of Public EV Charging Stations in PA:")
print(num_stations)

## The station names and coordinates are easily selected
stationNames <- filtered_stations$Station.Name
latitude <- filtered_stations$Latitude
longitude <- filtered_stations$Longitude

## Create a custom data frame with station coordinates and names
## Leaflet is sensitive to large datasets
station_data <- data.frame(
  Name = stationNames,
  Latitude = latitude,
  Longitude = longitude
)

# Create the leaflet map
EVchargemap <- leaflet(station_data) %>%
  setView(lng = -77.8124, lat = 40.86833, zoom = 6) %>%  # Center the map around State College, PA
  addTiles() %>%  # Add map tiles as the base layer
  addMarkers(lat = ~Latitude, lng = ~Longitude, popup = ~Name)

# Display the map
EVchargemap
```




Answer: There are 931 charging stations available for public use in PA. Generally, if we travel along the US Interstate System, we can reliably recharge an EV.

# RAW DATA -- INTERNATIONAL ENERGY AGENCY (IEA)

| | region | category | parameter | mode | powertrain | year | unit | value |
|---|---|---|---|---|---|---|---|---|
| 1 | Australia | Historical | EV stock | Cars | BEV | 2011 | Vehicles | 49.00000 |
| 2 | Australia | Historical | EV stock share | Cars | EV | 2011 | percent | 0.00046 |
| 3 | Australia | Historical | EV sales share | Cars | EV | 2011 | percent | 0.00650 |
| 4 | Australia | Historical | EV sales | Cars | BEV | 2011 | Vehicles | 49.00000 |
| 5 | Australia | Historical | EV sales | Cars | BEV | 2012 | Vehicles | 170.00000 |
| 6 | Australia | Historical | EV sales share | Cars | EV | 2012 | percent | 0.03000 |
| 7 | Australia | Historical | EV stock share | Cars | EV | 2012 | percent | 0.00280 |
| 8 | Australia | Historical | EV stock | Cars | BEV | 2012 | Vehicles | 220.00000 |
| 9 | Australia | Historical | EV stock | Cars | PHEV | 2012 | Vehicles | 80.00000 |
| 10 | Australia | Historical | EV sales | Cars | PHEV | 2012 | Vehicles | 80.00000 |
| 11 | Australia | Historical | EV sales | Cars | PHEV | 2013 | Vehicles | 100.00000 |
| 12 | Australia | Historical | EV stock | Cars | PHEV | 2013 | Vehicles | 180.00000 |
| 13 | Australia | Historical | EV stock | Cars | BEV | 2013 | Vehicles | 410.00000 |
| 14 | Australia | Historical | EV stock share | Cars | EV | 2013 | percent | 0.00540 |

Dataset:

- IEA Global EV Data 2023 (csv)
- No Missing Values
- EV encompasses BEV (battery electric vehicles) and PHEV (plug-in hybrid electric vehicles)
- Shares (percent) vs Stock (counts)

# TIDYING IEA DATA(INITIAL)

| | region | year | count |
|---|---|---|---|
| 1 | Australia | 2011 | 98 |
| 2 | Australia | 2012 | 550 |
| 3 | Australia | 2013 | 880 |
| 4 | Australia | 2014 | 3200 |
| 5 | Australia | 2015 | 5360 |
| 6 | Australia | 2016 | 6370 |
| 7 | Australia | 2017 | 9600 |
| 8 | Australia | 2018 | 14500 |
| 9 | Australia | 2019 | 29800 |
| 10 | Australia | 2020 | 33900 |
| 11 | Australia | 2021 | 68400 |
| 12 | Australia | 2022 | 126900 |
| 13 | Austria | 2010 | 350 |
| 14 | Austria | 2011 | 990 |
| 15 | Austria | 2012 | 1540 |
| 16 | Austria | 2013 | 3160 |
| 17 | Austria | 2014 | 5880 |
| 18 | Austria | 2015 | 9300 |
| 19 | Austria | 2016 | 16400 |

```
## wrangle data to include columns for: year, region, count of EVs
EV_ownership_region_year_raw <- EV_Global_Historical_raw %>%
  filter(unit == 'Vehicles', region != "World") %>%
  select(region, year, value) %>%
  group_by(region, year) %>%
  summarise(count = sum(value))
```

Goal: To keep only necessary  data

- filter to only vehicles and countries
- attributes: region, year, value
- EV count = BEV count + PHEV count

# TIDYING IEA DATA(CONTINUED)

## Q4: Global EV Usage by Year

CASE: A GIVEN YEAR

ATTRIBUTES: YEAR, COUNT OF EVS

```
## wrangled data to cases of years with attributes: year, count of EVs
EV_ownership_global_year <- EV_ownership_region_year_raw %>%
  group_by(year) %>%
  summarise(count = sum(count))
```

## Q5: EV Usage by Country since 2019

CASE: A GIVEN REGION

ATTRIBUTES: REGION, COUNT OF EVS

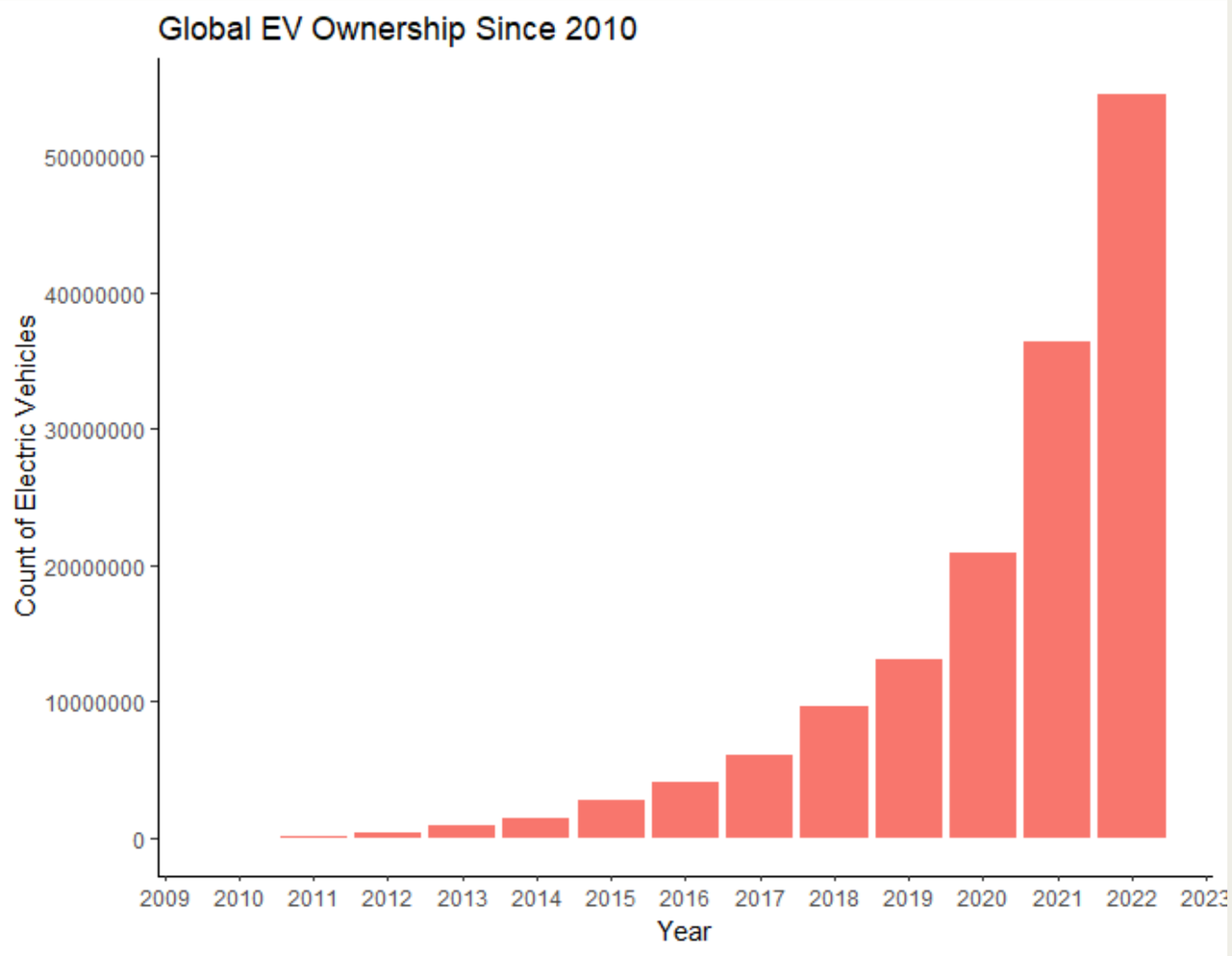
NOTE: ONLY WANT 2019-2022 TO MAKE DATA MORE RECENT

```
# Wrangle Data to get cases of regions from 2019-2022 with attributes: region, count
EV_ownership_region_2019_2022 <- EV_ownership_region_year_raw %>%
  filter(year >= 2019) %>%
  group_by(region) %>%
  summarise(count = sum(count))
```

# CREATING BAR CHART OF GLOBAL EVS OWNED EACH YEAR

```
### CREATE Bar Chart of Global EV Ownership by Year
global_ev_ownership_by_year_bar_chart <- ggplot(EV_ownership_global_year, aes(x = year, y = count, fill = 'red')) +
  geom_col() +
  scale_y_continuous(n.breaks = 8, limits = c(0, max(EV_production_global_year$count))) +
  scale_x_continuous(n.breaks = 11) +
  labs(title = "Global EV Ownership since 2010",
       x = "Year",
       y = "Count of Electric Vehicles") +
  theme_classic() +
  theme(legend.position = "none") # removes legend
```

# BAR CHART OF GLOBAL EVS OWNED EACH YEAR




## NOTES:

- EXPONENTIAL GROWTH
- OWNERSHIP INDICATES EVS IN STOCK AND SOLD TO CUSTOMERS

## REMINDER Q4:

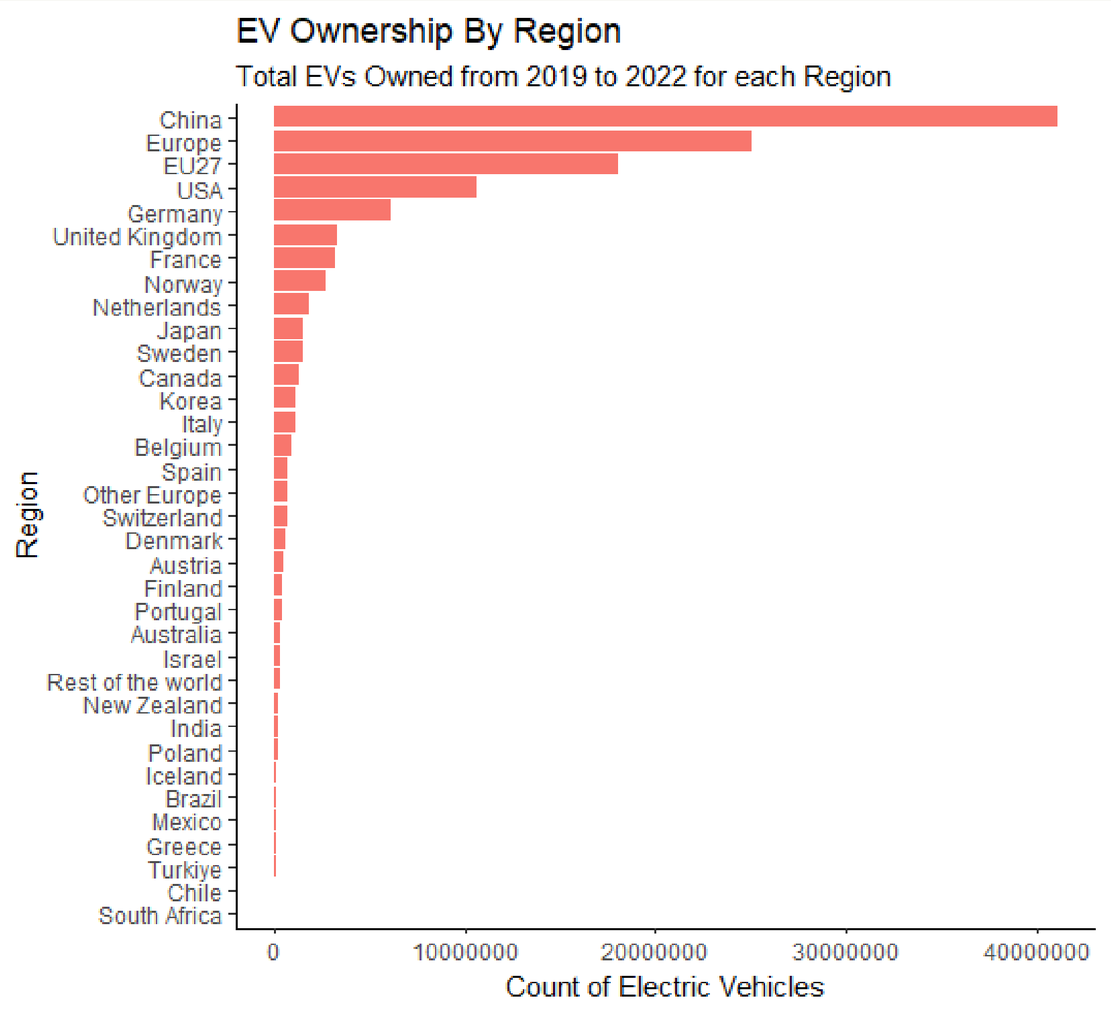
- HOW HAS GLOBAL EV USAGE CHANGED OVER THE YEARS?

# CREATING BAR CHART OF EVS OWNED BY COUNTRY

```r
# use y = reorder(region, +count) to order countries by car ownership
regional_ev_ownership_bar_chart <- ggplot(EV_ownership_region_2019_2022, aes(x = count, y = reorder(region, +count), fill = 'red')) +
  geom_col() +
  scale_x_continuous(limits = c(0, max(EV_ownership_order_by_country$count)), n.breaks = 9) +
  labs(title = "EV Ownership By Region",
       subtitle = "Total EVs Owned from 2019 to 2022 for each Region",
       x = "Count of Electric Vehicles",
       y = "Region") +
  theme_classic() +
  theme(legend.position = "none") # removes legend
```

**NOTES:** USED REORDER(COL1, +COL2) IN AES() TO MAKE COUNTRIES IN ORDER FROM HIGHEST COUNT OF EVS TO LOWEST COUNT OF EVS

# BAR CHART OF EVS OWNED BY COUNTRY




## NOTES:

- CHINA HAS MOST EVS (HIGHEST POPULATION)
- WHAT PERCENT OF EVS DO THE TOP 3 EV-OWNING COUNTRIES OWN?

## REMINDER Q5:

- WHICH COUNTRIES LEAD IN EV USAGE? WHICH COUNTRIES ARE LAGGING BEHIND?