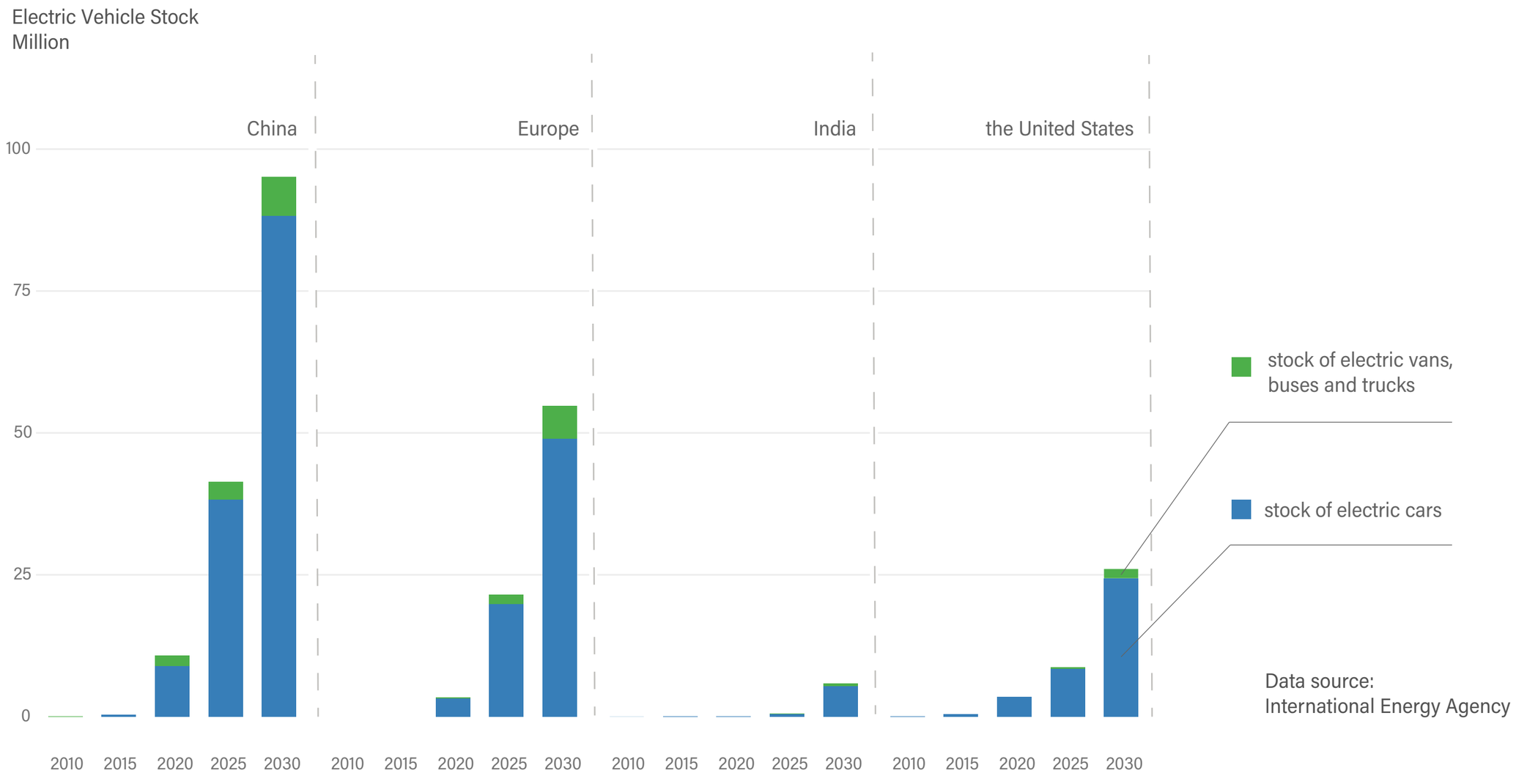
**Statement of Purpose**

In this diagram, as the title suggests, I want to convey the message that electric cars are dominant in the world among all types of electric vehicles. I plan to include this graph in my thesis. This will give my thesis readers a strong explanation as to why I chose electric cars and no other types of electric vehicles as the subject of my analysis.

By visualizing the International Energy Agency (IEA) dataset, using the agency's records of historical data and forecasts of the number of electric vehicles over the next decade under the IEA Stated Policies Scenario (STEPS), I show the market compositions of the world's four major electric vehicle markets: China, Europe, India, and the United States, between 2010 and 2030. For clarity, I have combined the categories other than cars: vans, buses, and trucks, because their combined numbers (in green) are far smaller than the share of cars alone.

# Cars dominate vehicle electrification in the past, present, and foreseeable future

## Electric vans, buses and trucks altogether account for little proportion of electric vehicles stock in key markets worldwide, 2010 – 2030



# 01

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2023-04-06

```
# Load packages ------------------------------------------------------------

library(tidyverse)
library(ggplot2)

# Load data ----------------------------------------------------------------

EV_2010_to_2021 <-
  read_csv('data_own/IEA-EV-data.csv')

# Data wrangling -----------------------------------------------------------

EV_cars_quantity <-
  EV_2010_to_2021 %>%
  filter(region %in%
           c('China', 'Europe', 'USA', 'India')) %>%
  filter(year %in%
           seq(2010, 2030, 5)) %>%
  filter(category != 'Projection-APS') %>%
  filter(parameter %in%
           c('EV stock')) %>%
  mutate(mode_new =
           if_else(mode == 'Cars',
                   'Cars',
                   'Vans, buses & trucks')) %>%
  group_by(region, year, mode_new) %>%
  summarise(value_new =
              sum(value))

  # Set the categorical variables as factors with certain orders

EV_cars_quantity$mode_new <-
  factor(EV_cars_quantity$mode_new,
         levels =
           c('Vans, buses & trucks', 'Cars'))

EV_cars_quantity$region <-
  factor(EV_cars_quantity$region,
         levels =

           # in alphabetical order

           c('China', 'Europe', 'India', 'USA'))
```

```
# Add percent numbers for reference

EV_cars_percent <-
  EV_cars_quantity %>%
  pivot_wider(names_from = mode_new,
              values_from = value_new) %>%
  mutate(percentage =
           formattable::percent(
             (`Vans, buses & trucks` /
                 (`Vans, buses & trucks` + `Cars`)))) %>%
  select(region, year, percentage)

# Combine the data together

EV_cars_all <-
  EV_cars_quantity %>%
  full_join(EV_cars_percent,
            by = join_by(region, year))

# Data visualization ----------------------------------------------------

p1 <-
  EV_cars_all %>%
  ggplot(mapping =
           aes(x = year,
               y = value_new,
               fill = mode_new)) +

  # only add some of the grid lines

  geom_hline(yintercept = 25000000,
             color = 'gray93') +
  geom_hline(yintercept = 50000000,
             color = 'gray93') +
  geom_hline(yintercept = 75000000,
             color = 'gray93') +
  geom_hline(yintercept = 100000000,
             color = 'gray93') +
  geom_bar(stat = 'identity',
           width = 3.2) +
  facet_wrap(~ region,
             nrow = 1) +
  geom_text(aes(label = percentage),
            size = 2.5,
            check_overlap = T) +
  scale_y_continuous(
    breaks = seq(0, 125000000, 25000000),
    labels = c('0', '25', '50', '75', '100', ''),
    limits = c(0, 125000000)) +
```

```
scale_fill_manual(values =
                    c('#4daf4a', '#377eb8')) +
labs(title = paste('Cars dominate vehicle electrification in the past,',
                   'present, and foreseeable future'),
     subtitle = paste('Electric vans, buses and trucks account for a little',
                      'proportion of electric vehicles in key markets worldwide'),
     caption = 'Data source: International Energy Agency',
     y = 'Million') +
theme_minimal() +
theme(axis.title.x = element_blank(),
      panel.grid = element_blank(),
      legend.position = 'none')
```

**Statement of Purpose**

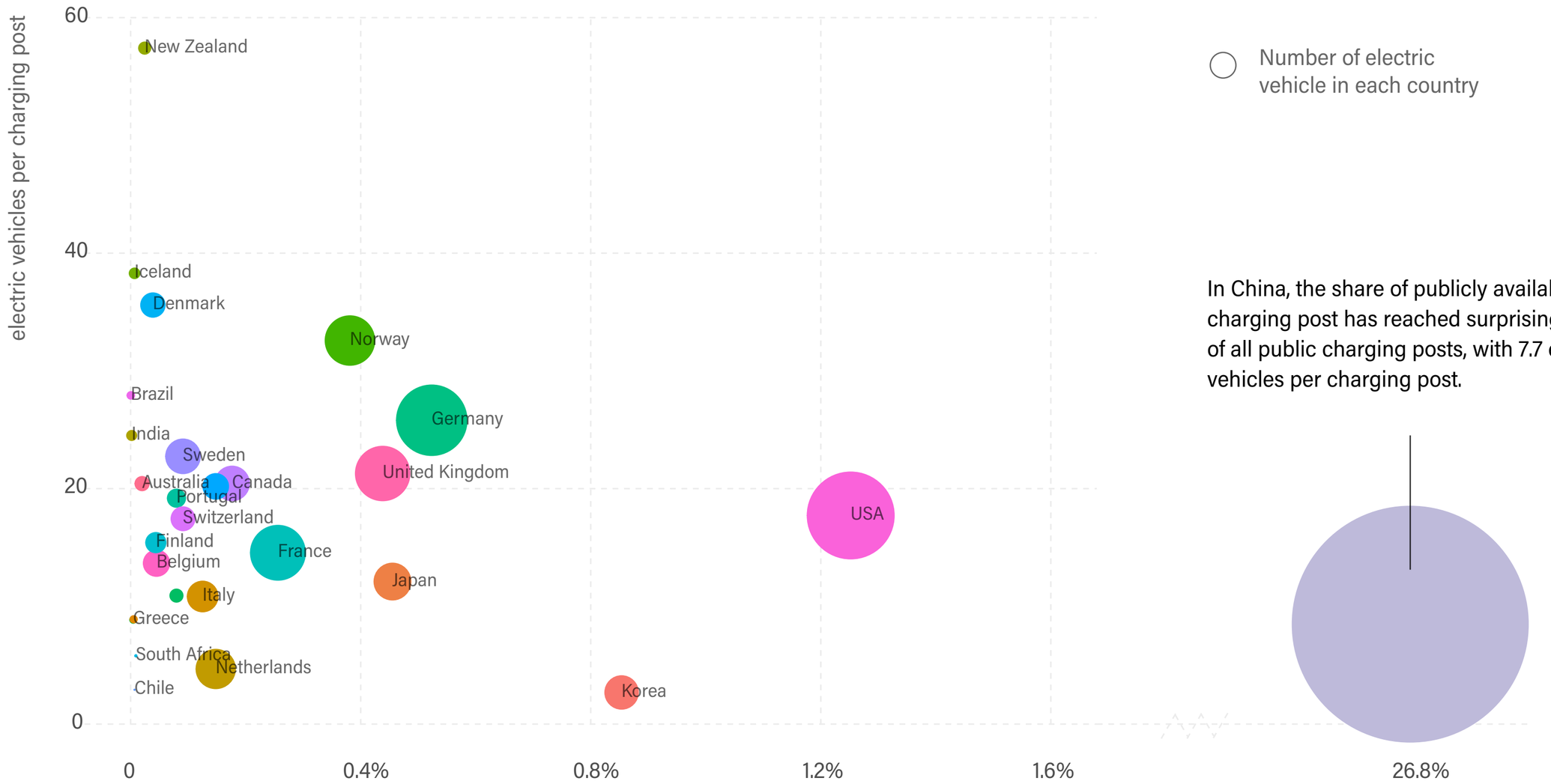
The deployment of publicly available chargers for electric vehicles typically lags behind the growth of electric vehicles (IEA, 2022). That is, in today's electrification of transportation, people sometimes buy electric vehicles (EVs) first, and then find out that publicly available charging facilities are insufficient. The deployment of EV charging facilities is the policy issue I want to examine in my paper.

The purpose of this graph is to show the level of EV charging deployment in different countries. The horizontal axis depicts the share of publicly available fast-charging posts, and the publicly available charging posts consist of both "slow" and "fast" charging posts. Fast charging posts can reduce charging time per vehicle and serve more vehicle owners in a given time frame, i.e., provide more charging capacity. The larger this number is, the fewer public charging posts are available for each EV, and the closer to 0, the more charging posts are available for each vehicle. Finally, the size of the bubbles shows the current number of registered electric vehicles in a country and represents the demand for electric vehicle charging in that country.

China (26.8%) is far ahead of all other countries (less than 2%) on the horizontal axis, while also being close to zero on the vertical axis. At the same time, China has the largest bubble, indicating that it has the most electric vehicles. All this reflects the booming development of electric vehicles in China.

# China is leading in EV charging infrastructure depolyment, far more than the next 2: the US and Korea

## The deployment of EV charging posts in 2021




Data source: International Energy Agency

Number of electric vehicle in each country

In China, the share of publicly available fast charging post has reached surprisingly 26% of all public charging posts, with 7.7 electric vehicles per charging post.

# 02

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2023-04-06

```
# Load packages ------------------------------------------------------------

library(tidyverse)
library(ggplot2)
library(colorspace)

# Load data ----------------------------------------------------------------

EV_2010_to_2021 <-
  read_csv('data_own/IEA-EV-data.csv')

# Data wrangling -----------------------------------------------------------

# Create a initial data set

EV_initial <-
  EV_2010_to_2021 %>%
  filter(!region %in%

           # exclude the regional data, in order to focus on countries

           c('Europe', 'Rest of the world', 'Other Europe', 'World')) %>%
  filter(parameter %in% c('EV stock', 'EV charging points'),
         year == 2021,
         category == 'Historical')

# Number of electric vehicles per charging point

EV_per_charging <-
  EV_initial %>%
  group_by(region, parameter) %>%
  summarise(value_new =
              sum(value)) %>%
  pivot_wider(
    names_from = parameter,
    values_from = value_new) %>%
  mutate(EV_per_charger =
           `EV stock` / `EV charging points`) %>%
  select(region, EV_per_charger)

# The share of fast chargers in the total number of chargers

Fast_charger_share <-
```

```
  EV_initial %>%
  filter(parameter == 'EV charging points') %>%
  select(region, powertrain, value) %>%
  pivot_wider(
    names_from = powertrain,
    values_from = value) %>%
  mutate(fast_percentage =
           `Publicly available fast` /
           sum(`Publicly available slow`, `Publicly available fast`)) %>%
  mutate(fast_percentage =
           formattable::percent(fast_percentage)) %>%
  select(region, fast_percentage)

# The total number of electric vehicles

EV_number <-
  EV_initial %>%
  filter(parameter == 'EV stock') %>%
  group_by(region) %>%
  summarise(EV_total = sum(value))

# Combine the created variables into one data frame

EV_analysis <-
  EV_per_charging %>%
  full_join(Fast_charger_share) %>%
  full_join(EV_number) %>%

  # exclude the missing values

  filter(!is.na(EV_per_charger)) %>%

  # to make visualization neater, arrange the order

  arrange(EV_number) %>%

  # we found that the fast charger percentage for China is an outlier, since
  # China's percentage of fast chargers are way higher than other countries
  # Exclude China for now

  filter(region != 'China')

# Data visualization ----------------------------------------------------

# generate a color palette

palette <-
  rainbow_hcl(27)

# create a bubble chart
```

```
p2 <-
  EV_analysis %>%
  ggplot() +
  geom_point(
    aes(x = EV_per_charger,
        y = fast_percentage,
        size = EV_total,
        color = palette)) +
  scale_size(range = c(.1, 30),
             name = 'Number of Electric Vehicles') +
  coord_flip() +
  geom_text(
    aes(
      x = EV_per_charger,
      y = fast_percentage,
      label = region),
    hjust = 'left',
    size = 3,
    check_overlap = T) +
  scale_x_continuous(
    breaks = seq(0, 60, 20)) +
  scale_y_continuous(
    breaks = seq(0, 0.016, 0.004),
    labels = c('0', '0.4%', '0.8%', '1.2%', '1.6%'),
    limits = c(0, 0.016)) +
  labs(title = paste('China is leading in EV charging infrastructure depolyment,',
                     'follows by the US and Korea'),
       subtitle = 'The deployment of EV charging posts in 2021',
       caption = 'Data source: International Energy Agency',
       x = 'electric vehicles per charging post',
       y = 'share of publicly available fast charging post') +
  theme_minimal() +
  theme(panel.grid.minor = element_blank(),
        panel.grid.major = element_line(linetype = 'dashed'),
        legend.position = 'none')
```