EV Power - Lab 4 Project Report

Part 0: libraries

```
library(sf)
library(rnaturalearth)
library(maps)
library(dplyr)
library(tidyr)
library(stringr)
library(ggplot2)
```

Part 1: Defining Research Question

Chosen Question: How has the share of renewable energy changed from 2021–2023 across states? What is the share of electricity that comes from clean sources by state?

Part 2: Data Preparation and Cleaning

```
renew2021 <- read.csv("data/renew-use-2021.csv")
renew2022 <- read.csv("data/renew-use-2022.csv")
renew2023 <- read.csv("data/renew-use-2023.csv")
total2021 <- read.csv("data/total-use-2021.csv")
total2022 <- read.csv("data/total-use-2022.csv")
total2023 <- read.csv("data/total-use-2023.csv")
```

```
renew2021 <- renew2021|>
    mutate(Renewable_Use_2021 = as.numeric(str_extract(Renewable_Use_2021, "\
\d+\\.?\\d*")))
renew2022 <- renew2022|>
    mutate(Renewable_Use_2022 = as.numeric(str_extract(Renewable_Use_2022, "\
\d+\\.?\\d*")))
renew2023 <- renew2023|>
    mutate(Renewable_Use_2023 = as.numeric(str_extract(Renewable_Use_2023, "\
\d+\\.?\\d*")))
```

```
total2021 <- total2021|>
    mutate(Energy_Source = str_replace_all(Energy_Source, "[^A-Za-z]", ""))
total2022$Energy_Source <- total2021$Energy_Source
total2023$Energy_Source <- total2021$Energy_Source
```

```
standardize_state <- function(df) {
  df <- df |>
    mutate(State = str_to_upper(State))
  return(df)
}
renew2021 <- standardize_state(renew2021)
renew2022 <- standardize_state(renew2022)
renew2023 <- standardize_state(renew2023)
```

Part 3: Joining / Pivoting Datasets for Analysis

```
renew_2 <- full_join(x=renew2021, y=renew2022, by=c("State", "Energy_Source"))
renew_all <- full_join(x=renew_2, y=renew2023, by=c("State", "Energy_Source"))
head(renew_all)
```

```
  State Energy_Source Renewable_Use_2021 Renewable_Use_2022 Renewable_Use_2023
1    AK       Biomass               3153               3846               3404
2    AK    Geothermal                186                186                186
3    AK    Hydropower               5763               5846               6051
4    AK  Solar Energy                 45                 57                 67
5    AK   Wind Energy                451                475                380
6    AL       Biomass             198543             193932             189040
```

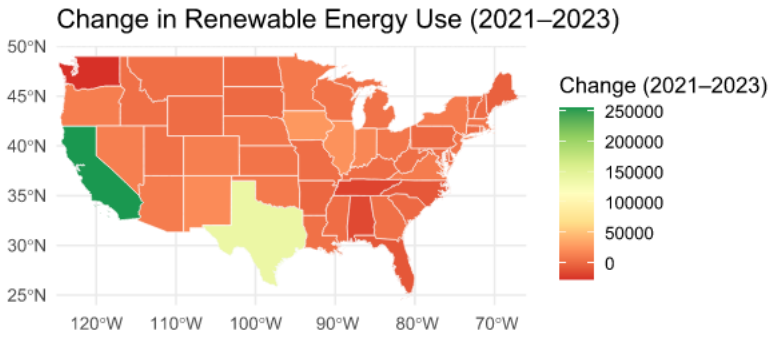
Part 4: Mapping Visualization

```
us_states <- ne_states(country = "United States of America", returnclass =
"sf")
renew_state_summary <- renew_all |>
  group_by(State) |>
  summarize(Renewable_Use_2021 = sum(Renewable_Use_2021, na.rm = TRUE),
Renewable_Use_2023 = sum(Renewable_Use_2023, na.rm = TRUE))
us_joined <- us_states |>
  left_join(renew_state_summary, by = join_by(postal == State))|>
  mutate(Change = Renewable_Use_2023 - Renewable_Use_2021)
renew_state_summary
```

```
# A tibble: 52 × 3
   State Renewable_Use_2021 Renewable_Use_2023
   <chr>              <dbl>              <dbl>
 1 AK                  9598              10088
 2 AL                239816             222189
 3 AR                 89714              87277
 4 AZ                 99266             108445
 5 CA                810020            1065179
```

```
 6 CO                103956             115062
 7 CT                 49306              48983
 8 DC                  2487               2796
 9 DE                  7151               8040
10 FL                297290             286307
# ℹ 42 more rows
```

```
ggplot(us_joined) +
  geom_sf(aes(fill = Change), color = "white") +
  scale_fill_distiller(
    palette = "RdYlGn",
    direction = 1,
    name = "Change (2021–2023)")+
  labs(title = "Change in Renewable Energy Use (2021–2023)") +
  coord_sf(xlim = c(-125, -66), ylim = c(24, 50), expand = FALSE) +
  theme_minimal()
```



The map shows that renewable energy use has gone up in most states between 2021 and 2023, but the change is not even everywhere as when some states in the West and Northeast show bigger growth in renewables, some Southern and Midwestern states have smaller changes or almost none. This might be because of differences in how much each state invests in renewable projects or how heavily they rely on other energy sources like coal or gas. When looking at the color scale, we can easily see states like California and Texas are leading in renewable energy growth and fossil-fuel-heavy regions (e.g., parts of the South) lag behind.